THE BENEFITS OF COMPLIANCE WITH THE ENVIRONMENTAL ACQUIS FOR THE CANDIDATE COUNTRIES

SUB-STUDY ASSIGNMENT REQUEST N°3

DGENV CONTRACT: ENVIRONMENTAL POLICY IN THE APPLICANT COUNTRIES AND THEIR PREPARATIONS FOR ACCESSION

Service Contract B7-8110 / 2000 / 159960 / MAR / H1

FINAL REPORT

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Final Report: Executive Summary

A. INTRODUCTION

A.1. Aim of the Sub-study

The aim of this study is to explore and estimate the environmental, economic and social benefits that are likely to arise from the full implementation of the EU environmental legislation (known as the "*acquis communautaire"*) in the candidate countries.

The debate has to date often focused on the costs of compliance with EU legislation and the difficulty of finding sufficient money to fund the necessary investments. There has, however, been little discussion about the benefits that EU environmental directives will imply for the candidate countries, both in environmental and economic terms. The hidden costs to the economy caused by lower environmental standards through a loss of output and inefficient production have not been taken properly into account. An analysis of the benefits resulting from implementing EU environmental legislation in the candidate countries is necessary to get a full understanding of the real effects of their accession to the EU and to ensure that environmental concerns are given the attention, priority and funding that they deserve.

To address the imbalance in the debate, this study explored the benefits of compliance, in three steps:

- **Type of Benefits:** what types of benefits arise from implementing the acquis and some examples of these benefits in the candidate countries – e.g. health impacts, impacts on agriculture, buildings (these are usually referred to in the report as *"Qualitative benefits").*
- **Extent of Benefits**: What is the extent of the benefits – e.g. how much are emissions reduced and how many cases of respiratory diseases are avoided? (These are usually referred to in the report as *"Quantitative benefits"*).
- **Value of Benefits:** What is the economic value of the avoided costs – e.g. how much would the reduced emissions and damages avoided by implementing EU directives be worth? *(*These are usually referred to in the report as *"Monetised benefits"* and are given in million EUR).

We need to keep in mind that it is not always possible to clearly evaluate the impacts of an EU directive and, where it is possible, there is always considerable uncertainty in doing so. The final step, estimating the value of benefits, is the most difficult. The benefits represent the level of income people would be willing to give up for a specific benefit, for instance clean drinking water or avoiding illness, and the value to the society as a whole of avoiding a number of cases of premature death. They are not a measure of increased national wealth or GDP. Whilst people (and government and industry) make decisions that have an impact on their environment every day - the acceptance of a certain level of pollution is in itself proof that people (if aware of the pollution and can avoid exposure to pollution) do not value their health above all other concerns. Despite the difficulties, estimating the value of the benefits of implementing the environmental directives offers a valuable tool to highlight the importance of the benefits.

It is important to note that it was explicitly decided not to explore the relation of the benefits assessment with existing cost of compliance estimates for the various environmental media and directives. It was felt that this was firstly inappropriate given that the benefits that could be have monetary values attributed is only to a subset of the full range of benefits (see Section A1.4.1), and that it is not easy to attribute a particular benefit to a particular directive given the inter-relation between directives. While a broad comparison can be useful between costs and benefits to highlight the fact that the benefits (that were able to be monetised) are significant and should be given serious consideration in decisions, a narrow comparison on a directive-by-directive basis is inappropriate. Some readers will undoubtedly carry out such an exercise, and the study team warns against any simplistic comparison that does not take the other benefits into account that could not be monetised, and does not take into account the interrelation of directives in providing the benefits.

A.2. This executive summary and the study team

This executive summary highlights key results from an in-depth analysis across the thirteen candidate countries carried out within the context of the DGENV study contract: ***Environmental Policy in the Applicant Countries (EPAC) and their Preparations for Accession.*** This benefits study ***- The Benefits of Compliance with the Environmental Acquis for the Candidate Countries*** – is a sub-study of the overall EPAC study. The sub-study was led by ECOTEC Research and Consulting Ltd, and supported by the Institute of European Environmental Policy (IEEP), EFTEC, Metroeconometrica, TME, and experts from across the candidate countries.

ECOTEC would like to thank the collaborators for their inputs to this sub-study:

- IEEP - for its specific role looking at the qualitative benefits in the water and air sectors;
- EFTEC - for looking at the monetary benefits from the water sector;
- Metroeconometrica - for looking at monetary benefits from the air sector;
- TME - for supporting the quantitative analysis; and
- Country experts from across the all thirteen candidate countries – for supporting both qualitative and quantitative analysis.

A.3. Background

The candidate countries are facing the very large challenge of transposing EU environmental directives into their national legislation, implementing and enforcing them. The environmental acquis comprises around 300 Directives and Regulations, including daughter directives and amendments, and has been estimated to require an investment of around 80 to 120 billion EUR for the ten Central and Eastern European countries alone[1]. This broadly amounts to annual investment costs of around 10 billion EUR. At the same time, the candidate countries are aligning with EU legislation in other policy

[1] Turkey, Cyprus and Malta not included

sectors as well. In many of these sectors, there are also considerable needs, but the resources, both financial and administrative, are limited.

In the environmental sector, some of the challenges include:

- Improving and extending the water supply networks to ensure that safe drinking water is available to all urban areas.
- Improving and extending waste water collection and treatment plants.
- Ensuring that air emissions from large combustion plants are reduced.
- Improving air quality, notably in many urban centres.
- Ensuring that dangerous substances released from installations are controlled and risks of accidents are minimised.
- Collecting, treating and disposing of waste from households, industry and hospitals.
- Cleaning up contaminated land and rivers where water quality is unacceptable.
- Protecting eco-systems, habitats and species from economic and environmental pressures.
- Reducing emissions from both passenger and freight transport.
- Reducing emissions of pollutants from economic sectors such as large industrial plants and agriculture.

These challenges are not unique to the candidate countries: all EU Member States have faced and still face many of these challenges. However, the candidate countries need to carry out particular efforts because of lower environmental investments in the past, particularly under the previous regimes. In some cases (e.g. regarding transport emissions), significant efforts might be needed to avoid the mistakes that the EU Member States have made.

Addressing these challenges can lead to a large number of benefits. These include:

- Better public health as exposure to pollution is reduced and, as a result, the number of respiratory diseases and premature deaths decreases.
- Less damage to forests, buildings, fields and fisheries through a reduction of acid rain and other forms of pollution – leading to wider economic benefits (increased yields) and reduced costs (building façade works).
- Lower risk of (irreversible) damage to natural resources such as groundwater aquifers.
- Better protection of natural ecosystems and (endangered) species.
- Promotion of tourism as a result of a cleaner environment (forests, bathing waters, nature reserves).
- Reduced risk of water-related illnesses and improved taste of water as a result of better bathing water and drinking water quality.
- Increased economic efficiency and higher productivity as a result of modern technology,

supporting competitiveness of industry.

- Lower production and maintenance costs through availability of cleaner water, reducing pre-treatment needs.
- Lower consumption of primary material as a result of a more efficient use and higher levels of reuse and recycling.
- Support for employment and benefits for local and regional development.
- Company culture benefits through improved awareness of environmental risks and approaches to minimise risks and respond to eventual events.
- Social benefits through greater learning, awareness, involvement and responsibility with regard to environmental matters (e.g. social responsibility and involvement in separation of waste and recycling).

The range and relative importance of the benefits will clearly vary across candidate countries, depending on the state of their environment, economic structures and pollution activities, consumption patters, and existing standards and related compliance levels.

Economic Growth and the Environment

The benefits will depend on the decisions taken by the candidate countries as well as the economic development path they choose. There are basically three options:

a) “Traditional Business-as-Usual”. Economic growth leading to increased environmental damage[2] and higher economic, social and health costs.

b) Economic development while reducing the impact on the environment. Applying cleaner technology and minimising waste without any fundamental change to economic decision-making.

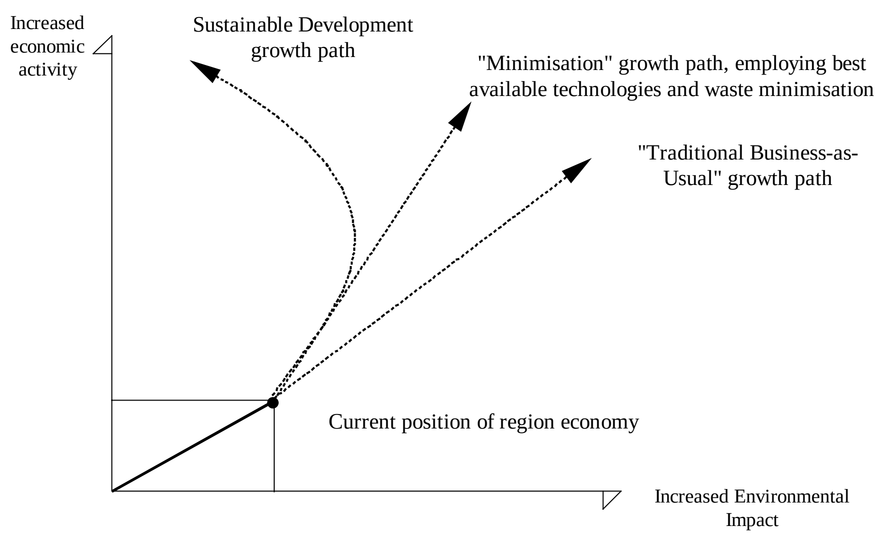
c) Sustainable development. Continued economic growth but with a significantly reduced impact on the environment taking fully into account environmental and social concerns into the decision making process.

The sustainable development option is less in line with the European Commission's proposal for a 6th Environmental Action Programme (and Sustainable Development Strategy) according to which the aim should be a continued economic and social development with due concern shown to the environment and natural resources. The three paths are noted in Figure ES.1.

Where there is an understanding of the full range of benefits of implementing the acquis, and where decisions reflect this understanding, implementation will contribute towards adopting the sustainable development path.

2 This is overall true for many economies, though clearly there are sectors and issues for which environmental impacts are decreasing despite economic growth. Successes include the reduction of acidic emissions from the power sector for example. Examples of failures relates to increased CO2 emissions from transport. In addition, there are certain times when economic restructuring leads to significant environmental benefits through often one-off gains (closure of aged polluting plant). Once this process is complete, the same pressures on the environment related to economic growth will resume. It certainly in the case in most of the candidate countries that the pollution intensity has dropped significantly since 1989.

Figure ES.1: Alternative Development Paths in the Accession Countries



A.4. Approach to analysis

A.4.1. Types of Benefits and coverage of Directives

As noted above, three tiers of analysis were undertaken – the qualitative, the quantitative and the monetary tiers. The qualitative assessment explored the type of benefits likely to arise from the specific requirements of the directives, and explored cases of such benefits in the candidate countries. It therefore examined each directive separately, though in some cases the benefits arise from the combined measures implemented resulting from several directives.

The main benefits explored include:

- Health benefits: direct benefits to public health, e.g. reduction of illnesses and avoidance of early mortality.
- Resource benefits: benefits to parts of the environment used commercially, e.g. forestry, agriculture and fisheries.
- Ecosystem benefits: benefits to the natural environment with no commercial interest.
- Social benefits: benefits to society at large, including safeguarding and access to natural and cultural heritage (avoided pollution damage to historic buildings), recreational opportunities (e.g. angling and bathing), social cohesion due to support for employment, societal learning and the development of civil society (due to increased information provision, consultation and involvement).
- Wider economic benefits: knock-on benefits beyond immediate economic exploitation, including

local and regional development (attracting investment) often supported by increased employment through environmental investments, eco-efficiency gains, development of new and existing industries/sectors of the economy, balance of payment and trade effects (reduced imports of primary materials as more waste is reused and recycled), and economic benefits from natural resources (e.g. tourism benefits of beaches recognised to be clean, and eco-tourism).

Where possible the sub-study sought to quantify these benefits, and further on to present a monetary assessment of the benefits – at each stage noting the assumptions and interpreting the results in the context of the methodologies. Given the difficulty of attributing monetary values to benefits (in some cases it is impossible), the economic estimates necessarily cover fewer benefits than the other two steps in the analysis. It is therefore especially important to look at each level of the analysis as offering valuable insights in itself and not only regard the qualitative as a step towards the quantitative which in turn is a step towards the monetary evaluation. Focusing only on the monetary analysis would be losing part of the richness of the analysis and indeed the value of benefits analysis.

It is clear that with each step – from qualitative analysis, to quantitative analysis, to monetisation, that fewer benefits can be covered. The analysis therefore offers a type of "benefits pyramid" (see Figure ES.2). Furthermore, the scope of the current study itself had limitations and some directives have not been covered. Given that these also lead to benefits, and often significant benefits, the full benefits of implementing the environmental acquis are larger than those covered here in the qualitative assessment.

Figure ES.2: Benefits Pyramid

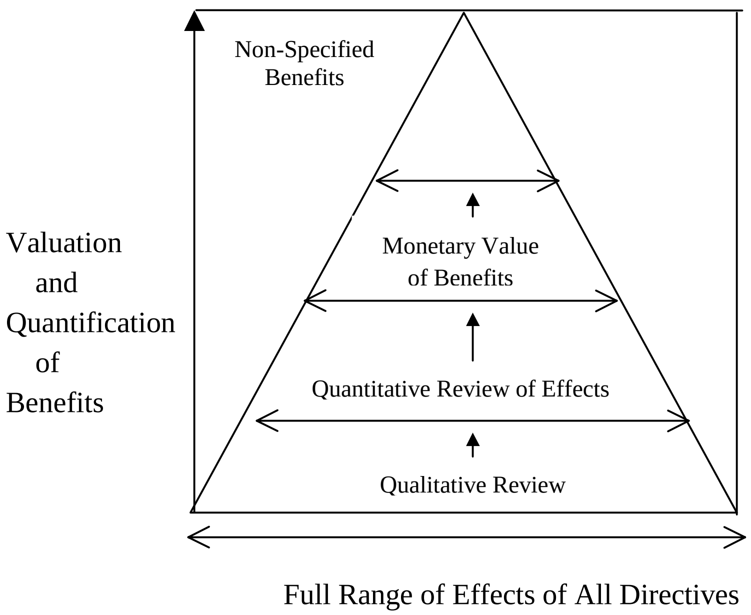


Table ES.1 presents a summary of the directives covered. It is important to note that the selection does not suggest that there are no or only marginal benefits from the proper implementation of other directives. For example it is clear that the following directives will have important benefits:

- EIA (85/337, amen. 97/11/EC) – the proper implementation of this directive will help reduce environmental impacts, taking local environmental sensitivities into account properly, and offer benefits to civil society of through information provision and participation.
- Ozone Depleting Substances (3093/94) – avoid contributions to the problem of the ozone hole, helping reduce the risk of skin cancer and cataracts globally;
- Public health: protection of individuals against ionising radiation in medical exposures (97/43/EURATOM) – reduced risk of exposure from radiation to both workers and general public
- The risk based directive on GMOs (2001/18/EC) – will reduce the risks associated with the release of GMOs
- Occupational safety and health: risks related to chemical agents (98/24/EC) – this would reduce occupational exposure for workers and hence protect health.

This issue of chemicals is particular important, but also particularly difficult to assess the benefits and considered outside the scope of the study. Again this does not imply that this was not considered important and an appreciation of the benefits will be important for related policies[3].

Table ES.1: The Acquis Communautaire, and Level of Analysis

Directive		Level of Analysis
A. Horizontal		Not estimated
EIA	85/337, amen. 97/11/EC	Not estimated
Access to information	90/313	Not estimated
Implementation Reports	91/692	Not estimated
Regulation – LIFE	1973/92. Amen	Not estimated
B. Air Quality		Monetary assessment
Air Quality Frame. + Daughters: PM10, SO2, lead, N20	96/62, 80/779,amen,	Monetary assessment
Tropospheric Ozone Pollution	92/72	Qualitative analysis
Emissions from motor vehicles, diesel engines, soot, etc	70/220, amen. etc	Qualitative analysis
VOC emissions from storage and transport of petrol	94/63	Qualitative analysis
Lead content of petrol, quality of diesel, sulphur content.	85/210, amen. etc	Qualitative analysis
Emissions from non-road mobile machinery	97/68	Qualitative analysis
Regulation – Ozone Depleting Substances	EC/3093/94	General description
C. Waste Management		Monetary assessment
Framework Directive on Waste	75/442/EEC+ 91/156/EEC and 96/350/EC	Qualitative analysis
Titanium Dioxide + daughters	78/176, am. 82/883, 92/112 etc.	General description
Air pollution: incineration of waste	2000/76/EC replacing. 89/369/EEC, 89/429/EEC, 94/67/EC	Monetary assessment

[3] See the White Paper: Strategy for a Future Chemicals Strategy, COM (2001) 88.

Directive		Level of Analysis
Landfill	1999/31/EC	Monetary assessment
Disposal of Waste oils	75/439, amen. 87/101/EEC	Qualitative analysis
Disposal of PCBs and PCTs	76/403/EEC amen 96/59	Qualitative analysis
Hazardous Waste	91/689, amen. 94/31/EC	Qualitative analysis
Sewage Sludge and Soil	86/278, amen.	Qualitative analysis
Batteries and Accumulators	91/157, amen. 93/86/EEC	Qualitative analysis
Packaging waste	94/62, amen. 97/129/EC	Monetary assessment
Toxic and Dangerous Waste	78/319/EEC	Qualitative analysis
Animal Waste	90/425/EEC, 90/667/EEC	Qualitative analysis
Control of Transboundary Movements of Haz. Waste and their Disposal (Basle Convention)	93/98/EEC	Qualitative analysis
Supervision and Control of Shipments of Waste	94/575/EC, 94/774/EEC, 96/660/EC	Qualitative analysis
Hazardous Waste List	94/904/EC	Not estimated
European Waste Catalogue	94/3/EC	Not estimated
Regulation – Shipment of Waste	EEC/259/93.	Not estimated
D. Water Quality		Monetary assessment
Water Quality Framework	2000/60/EC	Qualitative analysis
Dangerous Substances to aquatic environment	76/464, amen. etc	Monetary assessment: implicitly
Urban waste water	91/271, amen.	Monetary assessment: implicitly
Nitrates	91/676	Monetary assessment: implicitly
Bathing Water	76/160	Monetary assessment
Drinking Water	80/778, amen.	Monetary assessment: explicitly
Surface Water for drinking	75/440, amen.	Qualitative analysis
Measurement sampling of drinking water	79/869, amen.	Not estimated
Ground water	80/68, amen.	Qualitative analysis
Fish water	78/659, amen.	Qualitative analysis
Shellfish Waters	79/923, amen.	Qualitative analysis
E. Nature Protection		Qualitative analysis
Habitats	92/43, amen.	Quantitative analysis
Wild Birds	79/409, amen.	Part of Habitats
Seal Skins	83/129, amen.	Not estimated
F. Industrial Pollution Control		
Air Pollution from Industrial Plants	84/360, amen.	Monetary assessment
Large Combustion Plants	88/609, amen.	Monetary assessment
IPPC	96/61	Monetary assessment
Seveso - Control of Major Accident Hazards	96/82, amen.	Qualitative analysis
Industrial pollution: reduction of emissions of volatile organic compounds (VOC)	1999/13/CE	Monetary assessment
Regulation – Community eco-label award scheme	880/92 & 1836/93	General description

Directive		Level of Analysis
G. Chemicals and Genetically Modified Organisms		
Ozone Depleting Substances	Regulation 3093/94	Not estimated
Animal experiments, GMOs, laboratory practice et al	86/609, 90/219 am. etc	Not estimated
H. Noise from vehicles and machinery		
Motor vehicles, motor cycles, plant, aircraft, appliances	70/157, amen. + others	Not estimated
I. Nuclear Safety and Radiation Protection		
Radiation Protection of General Public & Workers etc	80/836, 97/43, 96/29 etc	Not estimated

A.4.2. Benefits and the Candidate Country Coverage

The study covers all thirteen candidate countries – Bulgaria, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovenia, Slovak Republic, and Turkey.

The assessment looks primarily at the benefits to each country resulting from their own domestic initiatives to implement the EU directives. However, some cross-border and trans-national impacts are also explored, in particular for air pollution. This includes benefits to EU Member States as well as to third countries.

B. BENEFITS OF COMPLIANCE: QUALITATIVE INSIGHTS

B.1. Overview of types of Benefits

Fully implementing the EU environmental directives will lead to significant benefits for health, resources, eco-systems as well as offering social benefits and wider economic benefits (see Table ES.2). Particularly important benefits are noted after the table. The extent of the benefits will clearly vary across candidate counties and vary according to the level of environmental standards in place in each country and the level of compliance with these standards.

Table ES.2: Types of Benefits

Benefit Type	Air	Water	Waste	Nature
Health	Avoided respiratory illnesses and premature deaths	Households access to and confidence in clean drinking water, clean bathing waters	Reduced risk of poisoning and accidents due to methane leakage from landfills	None assessed
Resources	Avoided damage to buildings and crops	Cleaner groundwaters (aquifers) and surface waters bathing waters	Reduced input of primary material, energy generation	None assessed
Eco-systems	Avoided global warming from CO2 emissions	Improved river water quality	Avoided global warming from methane emissions	Protected areas and species
Social	Improved access to cultural heritage (less damage to historic buildings)	Angling and recreation in rivers, lakes and beaches	Awareness of own responsibility and impacts on the environment	Access to protected areas
Wider Economic	Cultural tourism. Attracting investment. Employment through provision of environmental goods	Increased tourism to recognised clean beaches; reducing pre-treatment costs and attracting investment given locational quality	Reduced primary materials imports. Attracting investment given locational quality.	Eco-tourism

B.2 Benefits to Health, Resources, Eco-Systems, Social Benefits and Wider Economic Benefits

Health benefit

The following benefits arise throughout most if not all the candidate countries, where pollution levels are currently significant and will be reduced through the implementation and enforcement of EU environmental legislation:

- Fewer respiratory diseases and fewer cases of premature death as a result of improved air quality. Benefits are expected across all candidate countries and are particularly important for particulate matter and urban ozone. Reduction in exposure to volatile organics compound (VOC) emissions and dioxins will also offer significant benefits. This pollution arises mainly from emissions from power stations, industry and traffic. Implementing the Large Combustion Plant Directive (LCPD), the Integrated Pollution Prevention Control (IPPC) Directive, the Incineration Directives, Fuel Quality Directives, the VOCs Directive, and the Air Framework Directives will help address these problems.

- Safer environment for children as a result of lower lead emissions, particularly from industry and fuels. These problems can be minimised through the IPPC Directive for industry and the Fuel Quality Directives for lead emissions from transport.
- Better health as a result of less dioxins and heavy metals emitted from below standard incinerators. This can cause cell malfunctioning, either directly, through respiration, or indirectly, though absorption in the food chain. The implementation of the Incineration Directives will help address this problem and reduce the risk of cancers and malformations.
- Positive health impacts and improved safety from a better management of landfill sites and of hazardous waste as well as the capture of landfill gas, which can cause explosions or leakages (where the landfill is not a technically secured landfill). These benefits result from implementing the requirements of the Landfill Directive.
- Fewer cases of gastric illness and irritations to skin caused by poor water quality and high concentrations of contaminants in polluted rivers, lakes and coasts. Implementing the Urban Waste Water Treatment Directive can help avoid these negative impacts on health. This will be particularly beneficial where the downstream rivers, lakes and coastlines are of significant recreational value (e.g. coasts of Cyprus, Malta, Turkey).

Resource benefits

- Improved protection for fish stocks, which are damaged by current pollution levels. This is due to releases of heavy metals, excess fertilisers, untreated wastewater and pesticides. The implementation of the Directive on the Discharge of Dangerous Substances to water and the Urban Waste Water Treatment Directive will reduce these emissions.
- Reduction in the damage to agriculture through pollution loads. This can lead to significant benefits in yields.

Eco-system benefits:

- Better protection for eco-systems, which are under particular pressure from air and water pollution and from certain economic activities (e.g. road constructions and intensive agriculture). Acid rain is a significant pressure on land-based eco-systems, such as the Black Triangle – parts of Poland, Czech Republic and Germany. This problem will be reduced with the full implementation of EU air directives.
- Less damage for water based eco-systems, such as the Danube Biosphere Reserve, the Black Sea, and the Baltic Sea through improved water quality. The full implementation of the Directive on Discharge of Dangerous Substances to water and Urban Waste Water Treatment Directive should reduce pressures significantly.
- Positive impacts for eco-systems from improved waste management. For example, fewer

emissions of heavy metals and dioxins from incineration and less groundwater pollution from the illegal dumping of waste as well as from untreated waste. This damage can be reduced through the implementation of the waste directives.

- Finally, the implementation of the Habitats Directive may help reduce the damage to habitats from encroaching economic activities such as uncontrolled urbanisation in Turkey, intensive logging in the Birzai Forest of Lithuania or intensive agriculture practices on and around the designated protected areas around the Danube Delta.

Social Benefits

- Although not quantifiable, the social benefits both to the EU and candidate countries citizens in terms of better nature and species protection is expected to be significant. Furthermore, the existence of clean rivers and beaches supports leisure activity and quality of life. Furthermore civic society will benefit from the increased communication of information on the environment, increased consultation and involvement (e.g. consumer involvement in the packaging waste directive will help increase awareness of their role and impacts on the environment). Finally, employment can be supported by environmental expenditure (see below), supporting societal stability.

Wider development benefits:

- Economic development can be supported through the proper implementation of the EU directives. Notably the Bathing Water directive should support the tourism industry as clean beaches are certified. Furthermore, many companies should face lower treatment (e.g. less pre-treatment of water needed with better surface and ground water quality) and maintenance costs from the implementation of the directives. Furthermore, investment in and subsequent operation and maintenance of new infrastructure will lead to investment in the local economy, with positive knock-on effects on local and regional economic development, and supporting employment.
- The existence of clean air and water, combined with environmental infrastructures (connection to water supply, waste water treatment and waste collection system) can improve the "locational quality" of an area and help attract investment. "Locational quality" is a key driver for inward investment and for retaining high skilled labour, and while not possible to quantify or monetise, is a fundamental element of local and regional development policies, policies to attract foreign investment, and indeed a fundamental need for sustained economic development. Reduced demand for landtake, greater emphasis on efficiency of materials use, increased agricultural yields due to decreased air and water pollution, enhanced esthetical value of the environment (and increased tourism) can lead to wider development benefits if the waste directives are implemented. Also, increased emphasis on recycling and composting can encourage collection/reprocessing/secondary material manufacturing activities to develop, hence an employment benefit.

B.3 Indicative Evaluation of Benefits

An overview of the qualitative benefits associated with the directives is presented in Table ES.3 below. Clearly the benefits will not be the same in all countries, and this table should be seen as indicative.

Table ES.3. Overview of the Qualitative Benefits of Compliance

Directive	Overview of Benefits				
	Health Benefits	**Resource Benefits**	**Eco-systems**	**Social Benefits**	**Wider Development**
Air Quality					
Air Quality Framework + daughters: PMs, SO2, Pb, NOx	***	***	***	**	**
Tropospheric Ozone Pollution	**	**	**	**	**
VOC-Solvents	**	*	**	*	*
Regulation - Ozone-Depleting Substances	*	*	*	*	
Lead Content of Petrol, Quality of Diesel Fuel	***	-	*	**	*
Industrial Pollution Control					
Air Pollution from Industrial Plants	Included in IPPC				
Large Combustion Plants	***	**	***	***	**
IPPC	***	**	***	***	**
Waste Management					
Framework Directive on Waste	**	*	**	**	**
Titanium Dioxide and daughters	**	*	*	*	
Incineration of Waste	***	**	**	**	*
Landfill	**	*	**	**	*
Disposal of Waste Oils	*	**	**	*	*
Disposal of PCBs and PCTs	**	*	*	*	
Sewage Sludge	*	*	*	*	*
Batteries and Accumulators	*	*	**	*	*
Packaging and Packaging Waste	*	*	**	**	*
Water Quality					
Proposed Water Quality Framework	*	*	***	**	**
Dangerous Substances to Aquatic Environment	**	**	***	***	**
Urban Waste Water	***	**	***	**	*
Nitrates from Agricultural Sources	**	**	**	**	*
Bathing Water	**	**	**	**	***
Drinking Water	**	**	**	**	*
Surface Water for Drinking	**	**	**	*	*
Ground water	**	**	**	*	*
Fish water	**	***	**	**	**
Shellfish Water	*	**	**	*	*
Nature Protection					
Habitats	-	*	***	***	**
Wild Birds	-	*	***	***	**

*Key: Very Significant Benefits: ***; Significant Benefits: **; Some Benefits:* *

C. QUANTIFYING THE BENEFITS

C.1. Summary of Method – what can be quantified

Knowing in qualitative terms the benefits arising from the implementing of the acquis does not directly lead to an ability to quantify the benefits. As noted above, part of this is due to lack of data, part is due to methodological limitations and limitations of scientific knowledge, and part due to the difficulty of attributing a benefit to a particular cause, as often there are multiple causes for a benefit.

The table below present what benefits the study team were able to quantify with the available data.

Table ES.4: Benefits Quantified across Media

Benefit Type	Air	Water	Waste	Nature
Health	Respiratory diseases	Number of households benefiting from improved water quality	Not quantified	Not quantified
Resource	Building stock; Crops	Reduction of contaminants in surface water	Reduced primary inputs	Not quantified
Eco-systems	Global climate	Likely changes in river water quality	Avoided methane emissions	Protected areas, species
Social	Not quantified	Not quantified	Not quantified	Not quantified
Wider	Employment	Employment	Employment	Not quantified

Note: The sources for information combine statistical yearbooks from the candidate countries, ministry and institute publications, European Commission funded studies (e.g. Phare and DISAE) and input from the candidate country experts.

C.2 Overview of the extent of the benefits

The implementation of the EU directives in the candidate countries will reduce the pressures on the environment through a reduction in pollution emissions and deposition and, subsequently, diminish their negative impact, for example on public health. The following list gives some examples of the extent of these benefits.

- **Air:** Emissions of particulates from the candidate countries is expected to fall by between 1,8 and 3,3 million tonnes. Without EU directives, emissions would be expected to stand at 3,7 million tonnes in 2010. As regards the impact of these particulates on human health, the study suggests that between 15.000 and 34.000 cases of premature deaths across the candidate countries will be avoided through the implementation of EU air directives in 2010.
- **Water:** Across the candidate countries, most households are expected to benefit from improved drinking water quality and confidence in this quality. Particular benefits will accrue to those currently without supply as new connections are put in place - for example between 20% and 30% of all households in Turkey, Bulgaria and Estonia currently are not connected, many of which could stand to gain from infrastructure extensions. The benefits include issues of consumer preference on issues such as better taste, colour and smell of water, confidence in quality, as well

as health improvements due to reduced contamination. Similar benefits are expected from improved bathing water quality.

- **Waste:** Methane emissions will, through the Landfill Directive, fall by some 0,6 to 6,4 million tonnes annually by the year 2020[4]. The Directive on Packaging Waste will also imply that the amount of packaging waste recycled by all candidate countries will increase by 3,7 million tonnes per year by 2020.
- **Nature:** The size of protected areas, as percentage of total country surface, will increase and the level of protection of these areas will in many cases improve. The forecast increases in protected areas stems primarily from national strategies and plans rather than the acquis, but the issue of the level of protection will be supported by the appropriate implementation of the acquis. The increase in protected area is expected to range from: 26 percentage points (pp) in Slovenia (from 6% of total surface area to 32%), 10 pp in Malta (from 18% to 28%), 8 pp in Lithuania (from 11% to 19%), and around 2,5 pp in Bulgaria (5% to 7,5%) and Estonia (16% to 18,3%).

C.3. Extent of the Benefits: Air

The study has assessed the extent of the benefits from lower emissions for the following pollutants: particulates, sulphur dioxide (SO2), nitrogen oxides (NOx), volatile organic compounds (VOCs), carbon dioxide (CO2), carbon monoxide (CO), heavy metals and tropospheric ozone. The analysis does not cover dioxins, traffic related ozone emissions or methane (CH4). The results are therefore underestimated as dioxins and ozone have significant impacts on health and methane is an important greenhouse gas. The main benefits arise from lower emissions of particulates (PM10), of the acid gases SO2 and NOx, ammonia (NH3) and volatile organic compounds (VOCs). Carbon monoxide and carbon dioxide are considerably less important.

EU directives will reduce the emission of particulates by some 1,8 to 3,3 million tonnes in 2010. By that year, total emissions of particulates are expected to range from 0,4 to 1,8 million tonnes, with full implementation. Without implementation of EU directives, this would amount to 3,7 million tonnes. This reduction will reduce the risk of respiratory diseases (e.g. bronchitis, asthma), hospitalisation and premature deaths. The study suggests that between 15.000 and 34.000 cases of premature deaths will be avoided every year across the candidate countries through full implementation of EU directives in 2010.

Without EU directives, total SO2 emissions of the candidate countries are expected to stand at some 7 million tonnes in 2010. Full implementation of the EU directives (not taking into account the currently discussed new Large Combustion Plant Directive) will reduce these emissions to some 4 to 5 million tonnes. Likewise, NOx emissions are expected to fall from around 3 million tonnes in 2010 to 2 million tonnes through compliance with EU directives. This reduces the damage to buildings, crops as well as the incidence of respiratory diseases.

Some examples of these benefits include:

[4] The landfill directive provides for gradual implementation (with staged targets) with all provisions needed to be carried out by 2020. This is why this section uses 2020 rather than 2010 even though full implementation by some countries is possible by 2010.

- Between 43.000 and 180.000 cases of chronic bronchitis will be avoided in 2010 through the full implementation of EU air directives. A large number of these relate to Turkey, primarily due to the use of low quality lignite in power stations.
- As mentioned above, between 15.000 and 34.000 cases of premature deaths can be avoided through improved air quality. Poland is expected to benefit the most, with between 7.000 and 14.000 fewer cases in 2010.
- Building surfaces “age” less quickly when they are not exposed to SO2 emissions. For example, lower air emissions should reduce the building surface of the Czech Republic needing maintenance by some 2,6 million square meters in 2010.
- Crop yields can increase when exposed to less SO2 - for example, the implementation of the EU directives may result in a 5% increase in the yield of wheat in Bulgaria in 2005.

C.4 Extent of the Benefits: Water

Drinking Water Quality

Households are expected to benefit from improved quality of drinking water and in some cases new access to (quality) drinking water. Examples of benefits include:

- For most households already connected (around 59 million across the candidate countries), there will be significant benefits from improved drinking water quality.
- In Turkey, around 6 million households (29%) are expected to benefit from new connection to drinking water supply systems with assured quality.
- In Bulgaria and Estonia, these values are similarly high (25% and 30% of all households respectively), while in other countries, a lower share of all households benefit.

River quality

The implementation of EU directives will significantly improve the quality of rivers in the candidate countries.

- In Bulgaria, 23 rivers are of ‘good’ quality, 18 of ‘fair’ quality, the rest is of either ‘bad’ or ‘very bad’ quality. After compliance with EU water directives, 41 rivers are expected to be of ‘good’ and 59 of ‘fair’ quality. In the other candidate countries, similar results are expected.
- The Czech Republic has the biggest river length of all the candidate countries (76.000 km). At the same time, 10% of rivers are of ‘fair’ quality, 10% of ‘very bad’ quality, while the remaining 80% are of either ‘poor’ (40%) or ‘bad’ (40%) quality[5]. Compliance with EU water directives will improve this situation considerably: 10% are expected to be of ‘good’ quality, and all rivers of ‘poor’, ‘bad’ or ‘very bad’ quality are expected to improve to fair quality after successful implementation.

[5] This applies the Czech Republic’s classification of water quality. According to this classification, "poor" quality is better than "bad" quality. The classification of river quality varies somewhat across candidate countries, so a country-to-country comparison should be seen in this context to avoid misleading interpretations. The important issue is the benefit within a country from improvements in river quality.

Recreational use of water

- The implementation of the Urban Waste Water Treatment Directive will lead to an improvement in the quality of coastal waters, rivers and lakes, particularly as result of reduced euthrophication following better treatment of waste water. Discharges of nutrients are expected to fall by between 33% in the Czech Republic to 67% in Poland and phosphorous discharges from 38% in Slovenia to 71% in Poland (see Part C of main report). This creates better opportunities for recreational activities, including tourism, as well as reducing danger to fish stocks.

C.5. Extent of the Benefits: Waste

The EU waste directives will lead to major changes in handling, treatment and disposal of waste in the candidate countries. The candidate countries have a wide range of ways in which they can choose to implement the set of waste directives. For example, they can choose to give priority to recycling or to incineration. This choice will affect the extent and value of the benefits arising from each directive. It is therefore not always possible to identify exactly what will occur as a consequence of a specific directive.

The main benefits from implementing the waste directives are:

- Lower pollution to groundwater and surface water from leakage of unprotected landfills and, as a result, lower risks of contaminating ground water aquifers and surface water, and hence lower the risks of contaminating drinking water.
- Reduced health and explosions risks as well as lower impact on global warming as methane emissions from landfills are captured and used to generate energy (with economic benefits). Existing landfill sites will have to be upgraded or closed according to specific standards and illegal dumping sites also properly closed.
- Benefits to eco-systems and other environmental resources as emissions from waste activities into air, water and soil are reduced and the recovery of energy is increased through the Incineration Directive.
- Increased efficiency in the use of material and reduced production of primary material as a result of higher levels of recycling. This is a result of the targets of the Packaging Directive as well as diversion targets from the Landfill Directive.
- Lower costs for waste collection, treatment and disposal, as less waste will be produced.
- Better management and monitoring of waste streams through the Waste Framework Directive.

EU waste directives will also help avoid:

- Pollution into air, soil and water (particulates, dioxins, heavy metals from sewage sludge, PCBs/PCTs, waste oil) and ecological risks from waste treatment sites and hazardous waste.
- Respiratory diseases and noise nuisance to local population, risks to health from air pollution and contaminated soil.

Extent of the benefits

- The full implementation of the Landfill Directive will lead to a reduction of methane emissions (captured) of between 0,6 and 6,4 million tonnes annually by the year 2020.[6]
- In spite of a 2% growth in waste generation, the Landfill Directive is estimated to reduce the waste disposed in landfills from some 59 million tonnes in 1998, to around 35 million tonnes by 2020 (instead of 89 million tonnes) if the candidate countries grant priority to recycling and around 20 million tonnes if incineration is chosen as the preferred option. Under the maximum recycling and composting scenario, around 54 million tonnes of diverted bio-degradable waste will be recycled or composted by 2020.
- In light of the Packaging Directive, recycling levels will, by the year 2020, have increased by 1,6 million tonnes for paper, around 39.000 tonnes for aluminium, and for all the recyclables together, around 3,7 million tonnes.

C.6. Nature Conservation

The benefits arising from the implementation of EU directives on nature conservation are mainly related to the setting-up of the Natura 2000 Network of special conservation areas in the candidate countries. Biodiversity and ecosystems will also benefit from other directives of the EU environmental legislation, for examples through better air and water quality (which reduce pressures on protected areas), but these are not covered in this section.

The main threats to ecosystems and bio-diversity in the candidate countries are:

- Acid rain and soil pollution from industry.
- Practices in agriculture, hunting, fishing and forestry that do not take environmental concerns into account.
- Construction linked to infrastructure (e.g. roads) and human settlements.

Implementing the Habitats and Wild Birds Directives will help address some of these problems by:

- In many cases, increasing the surface of protected areas.
- Raising the level of protection within existing protected areas.
- Identifying species to be protected.
- Adopting specific protection measures against identified threats faced by each designated area (e.g. forbidding pesticide use, increasing enforcement).

Extent of benefits

[6] As noted above, the landfill directive provides for gradual implementation (with staged targets) with all provisions needed to be carried out by 2020. This is why this section uses 2020 rather than 2010.

From 1997 to 2020, the size of protected areas (as a percentage of each country's total surface) is expected to increase, and the level of protection of these areas will in many cases be strengthened. While the increase in area is primarily driven by national strategies and concerns, the improvement in the level of protection will be influenced by the implementation of the acquis communautaire. Some examples of projected increases in the protected areas include:

- Bulgaria: + 2,5 percentage points, from 5 % to 7,5% of Bulgaria's total surface.
- Estonia: + 2,3 percentage points, from 16% to 18,3% of Estonia's total surface.
- Lithuania: + 8 percentage points, from 11% to approximately 19% of Lithuania's total surface.
- Malta: + 10 percentage points, from 18% to about 28% of Malta's total surface.
- Slovenia: + 26 percentage points, from 6% to 32% of Slovenia's total surface.

The second major benefit is the protection of threatened species. In the candidate countries, these species, in particular mammals, represent a substantial part of the countries' total species population.

Examples include:

- 19% in Romania,
- 15% in Turkey,
- 14% in Slovenia;
- 12% in Poland;
- 7,4% in Lithuania.

EU directives on nature protection will provide better protection for these and other species, including plant species.

C.7. Socio-Economic Benefits: Employment Benefits

Many socio-economic benefits are likely to arise from the full implementation of the EU acquis communautaire in the candidate countries. These will include:

- Support for **employment** in the eco-industries through increased investment and more developed infrastructure;
- Improvements in the **eco-efficiencies** of industry as new processes are put in place and existing activities, where relevant, made more sustainable – this will lead to a reduction in the resource intensity of production processes and a reduction in the amount of use of primary raw materials;
- The improvements in eco-efficiencies will undoubtedly help the **competitiveness** of many of the industries in the candidate countries, and support them in the process of entry to the competitive European internal market;
- In addition, there are clearly going to be some positive **enterprise-culture** developments that can lead to some economic benefits and avoided costs. This includes for example the likely impact of implementing the Seveso II (ComaH) Directive, as this should help reduce the likeliness of accidents and reduce the costs of accidents (see Part B)

The above is but a short list of the type of socio-economic benefits likely to accrue through the proper implementation of the acquis and parallel national efforts for the development of the economy. The assessment of employment impacts was the issue most amenable to a quantitative assessment, with summary results presented below and a detailed discussion presented in Part F of this study. This focuses on the level of employment that is likely to arise from the expected environmental expenditures required to implement the acquis – with a view of obtaining an “order of magnitude” estimate that allows the importance of the issue to be highlighted.

Summary Results of employment analysis

The total number of jobs that could be supported by environmental expenditure could reach 1.86m a year across the candidate countries of which around 480 thousand would relate to capital expenditure, with the remainder due to the provision of environmental services (e.g. waste collection), and the operation and maintenance of the environmental infrastructure. These values clearly present a strong message: a large number of jobs can be supported by environmental investments in the candidate countries.

The number has, however, to be seen in context. The basic assumption driving the analysis is that with lower wages, more labour will be used as a factor of production. This clearly will be the case, but only to some extent. The values should therefore be seen as an overestimate. However, using EU wage rates would have led to an underestimate, as clearly activities will be more labour intense with the lower wage rates in a number of candidate countries.

Furthermore, this analysis has only looked at the gross job creation, which, while important in employment market analysis for eco-industries, ignores the fact that the expenditure on environmental matters will imply a reduced expenditure in other areas, and consequently a potentially reduced level of employment elsewhere. It is clear that the net job creation would be significantly lower than the gross values noted above and there may well be no net job creation[7]. The analysis here is but a first cut analysis to highlight the importance of this issue. A fuller treatment of the employment implications of environmental investment is being carried out by the European Commission[8].

[7] This depends not only of the choice of where not to spend the money that is now allocated to the environment, but also on where the money is spend within the environmental domain. For example, Article 5 of the Landfill Directive can be met by increased use of recycling and composting, or increased incineration. In the former case more jobs will be supported than in the latter case, given the higher employment intensity of recycling/composting activities.

[8] The study - *Analysis of the EU Eco-Industries, their Employment and Export Potential* – is likely to be available towards the end of 2001.

D. MONETISING THE BENEFITS

D.1. Monetisation the benefits: what benefits have been valued

As stated above, knowing in qualitative terms the benefits arising from the implementing of the acquis does not directly lead to an ability to quantify the benefits. Furthermore, even in the cases where one is able to assess the extent of the benefits, not all benefits are amenable to having monetary values attributed to them. Again, part of this is due to lack of data, part is due to methodological limitations and limitations of scientific knowledge, and part due to the difficulty of attributing a benefit to a particular cause, as often there are multiple causes for a benefit. The table below summarises the benefits for which it has been possible to attribute monetary values.

Table ES.5: Benefits Monetised across Media

Type of Benefit	Air	Water	Waste
Health Benefits	Avoided early mortality and respiratory illness	Willingness to pay for clean drinking water’	Through external costs of emissions
Resource Benefits	Avoided damage to buildings and crops	Willingness to pay for clean bathing water	Reduced primary materials use
Eco-systems	Avoided global warming	Willingness to pay for improvements in river quality	Avoided global warming
Social Benefits	Not monetised	Not monetised	Not monetised
Wider Development	Not monetised	Not monetised	Not monetised

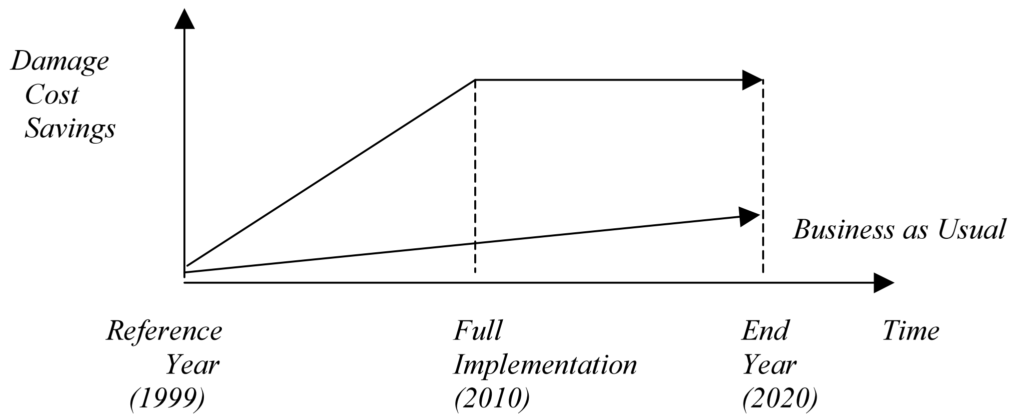
Note: Nature benefits were not monetised. For the Waste section, the overall benefits for compliance with the Landfill and Packaging Directives have been estimated, but not broken down by type of benefits.

D.2. Method for attributing monetary values to benefits

The basic valuation framework (Figure ES.3) seeks to capture the savings in damage costs to different ‘receptors’ (people, buildings, eco-systems, etc.) due to reductions in pollution and improvements in environmental management resulting from the Acquis.

The valuation of damage cost savings begins at a reference year (taken to be 1999, with the first year of benefits occurring in 2000), and reflects the increasing benefits as implementation proceeds, until fully implemented (core assumption is 2010; but sensitivity analysis has looked also at 2005 and 2020), and the continuing savings in the period thereafter (analysis used 2020 cut-off as benefits after this date becomes small due to the effect of discounting). This is the core valuation framework, but where appropriate a variant is used as the base case: namely for the treatment of the waste directives, where the 2020 is taken as the date for full compliance. The reason for this is that the Landfill Directive notes explicit targets, potentially going up to 2019, for reducing the amount of bio-degradable waste that can go to landfill.

Figure ES.3: Basic Valuation Framework



The savings are calculated as the net savings, using the level of pollution and damage in the reference year as the baseline for analysis. Sensitivity analysis has been carried out on a range of assumptions to this approach.

The benefits are calculated in terms of the amount in the full compliance year (2010 in core analysis), and a "net present value" (NPV) is also calculated for the benefits accruing over the period. The core discount rate assumed was 4%. Sensitivity analysis on the discount rate and the implementation time period were also carried out.

This monetisation is based on three approaches:

I. The application of unit pollution damage costs to estimated reductions in given pollutants *(unit damage per unit pollutant multiplied by avoided units of emission leads to avoided damage, in other words, benefits)* – this is the approach applied to the estimation of benefits from waste directives;

II. The application of unit receptor damage costs, to estimated reduction in damage to given receptors or receptor valuation of "damage" *(e.g. damage to building surfaces from air pollution for the former and the value of clean water per households for the latter)*;

III. The calculation of completed 'dose-response' function, relating pollution changes to effect, for particular receptors, capable of valuation in monetary terms *(multiply the dose (level of pollutant concentration), by the number of receptors (e.g. population), multiplied by the probability of illness/mortality (the DRF) and multiplied by the unit cost (e.g. of a range of illness such as bronchitis and asthma, the number of restricted activity days, hospital admissions, and premature mortality)* – this is the approach applied to the estimation of health benefits from air directives.

Benefits transfer and the use of purchasing price parities (PPP)

For the analysis most of the willingness to pay[9] (WTP) values, the dose response functions, and the unit cost values were based on scientific literature from the EU (ExternE work of DGResearch), EU Member States and the United States (see Part B on Air, Part C on Water and Part D on waste for references). There were very few values calculated specifically for the candidate countries. Hence a benefits transfer approach was used – the accepted method in valuations.

Within the benefits transfer analysis, the study team took the unit values and weighted them by the relative per capita purchasing price parities. In other words where an EU value for willingness to pay (WTP) for clean water was used, this was weighted according to the relative PPP of each candidate country and the EU. This leads to the willingness to pay for clean water to be lower in the candidate countries than in the EU, as could be expected. With no PPP weighting one assumes that the willingness to pay for clean drinking water is the same for all countries independent of income levels and purchasing powers. This would suggest PPP weightings make the results more sensible.

This approach becomes more delicate when talking of WTP for avoided illnesses (as surely the actual benefit of an avoided bronchitis is the same independent of whether it concerns a Bulgarian or Czech) – though had an actual WTP survey been carried out in different countries, the one would expect the actual WTP to be different. This basically highlights the problem that if one tries to attribute money values to health impacts, then this leads to ethical debates and problems. This debate is even more controversial when discussing premature mortality. In these instances it is important to bear in mind that the aim of a monetary evaluation is to highlight the importance of the problem, and not to suggest that the money value is an equivalent worth to the premature mortality (see Box ES1).

Given the above ethical concerns on the use and meaning of monetary valuations, the study team complemented the PPP approach, with a benefits analysis using non-weighted values. This leads to significantly higher benefits estimate than the PPP approach. As the agreed approach to benefits analysis is to ensure that benefits are weighted to PPP (in benefits transfer exercises), and given concern that using non-weighted values would overestimate the benefits, the core results presented here are those calculated using PPP weightings.

[9] A willingness to pay value (or range of values) is obtained by an extensive survey of consumers to ascertain the value they would attribute to the issue in question, whether clean water, cleaner beaches, reduced risk of bronchitis etc.

Box ES.1: "Valuing Life"

Significant controversy surrounds the valuation of impacts to human health, and particularly mortality. This relates to two principal issues: the 'moral' issues of 'valuing life', and the methodology by which values for health impacts are calculated. Much of the reaction to the monetary valuation of mortality stems from the unfortunate choice of terminology, such as 'the Value of a Statistical Life'. This does not mean the 'value of life' as used in everyday language, but is simply a convenient way to summarise information about people's willingness to pay for small reductions in risk. This makes it easier to compare the benefits of measures designed to reduce risks with the associated costs if the aggregate WTP and the number of lives saved are known.

Because of the high percentages of total benefits attributed to improvements in health, the methodologies and assumptions by which these benefits are calculated are of fundamental concern. A principal area of concern is the value placed on changes in the risk of premature mortality. Within this report, the approach taken has been to adopt VPF (Value of prevented fatality)[10], given the concerns regarding the use of the alternatives: the Value of Life Years (VOLY) approach.

The values used for the assessment in this report are the range of 0.7MEUR to 2.5 MEUR with a core value of 1MEUR. It is important to use a range to avoid suggesting an unrealistic precision in the result. See the Annex of Part B for a fuller discussion.

For the candidate countries, these values were weighed by the relative per capita purchasing price parity rations in the core analysis, and used without any weighting in a sensitivity analysis. The relative PPP is given in Table A.8 in Part A, and ranges from 0.3 in Bulgaria to 0.75 in Slovenia. In other words under the core analysis using PPP weighting (as is standard practice in benefits transfer analysis), the "core" value of prevented fatality would amount to 0.3MEUR in Bulgaria. In the "no weighting analysis" the value would be 1MEUR. The implications on the numerical value of the results are clear, with using EU incomes, the benefits would be much larger. While a sensitivity has been done without the weighting, in this report we have focused on the analysis using the weighting; this gives a more conservative estimate, but should be seen in the context of the ethical interpretation.

On the other hand using the PPP weighting means, for example in the context of health benefits, or biodiversity, that the value of a statistical life or an ecosystem is less in the candidate countries than in the EU. This is acceptable in neo-classical economic theory but raises difficult ethical choices in the use of the benefit estimates. It is important to reiterate that the aim of the analysis is to highlight the importance of avoiding pollution caused illness and early mortality. The VPF is therefore an indicator and not a statement of the worth of life.

[10] VPF is the term increasingly used. It represents the same value as VSL (Value of Statistical Life, sometimes known as VOSL), but adopts a different nomenclature.

D.3. Overview of monetised benefits

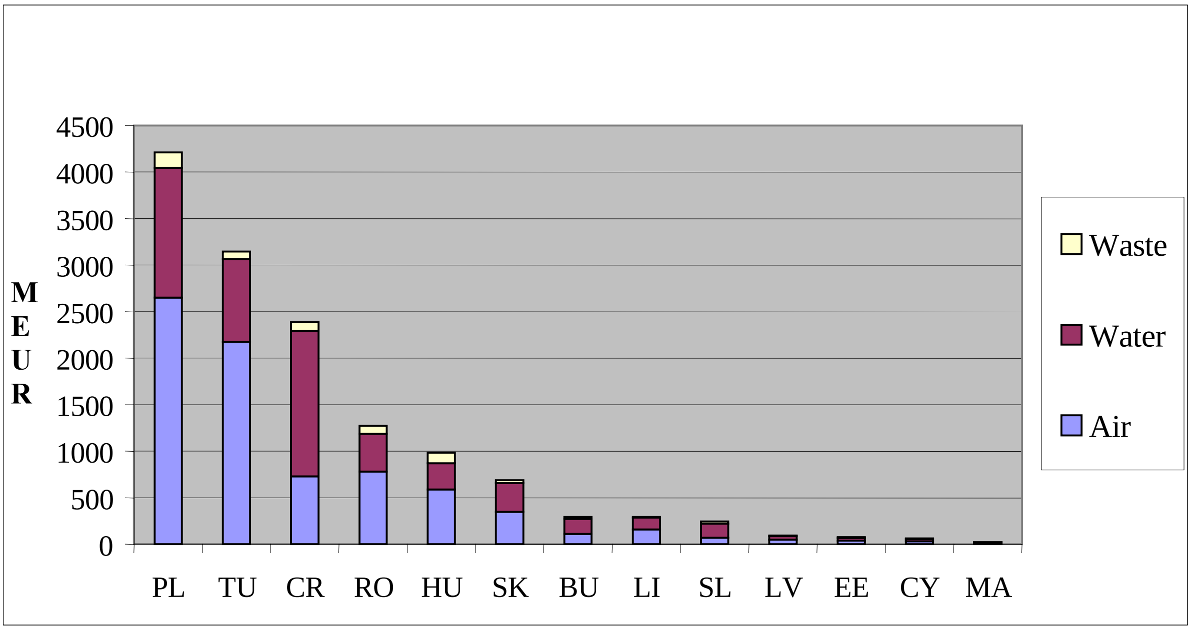
Where possible and sensible, an economic value has been estimated for these benefits. The annual benefits arising from full implementation amount to between 12,5 and 69 billion EUR (Table ES.6).

A single number cannot be given as this would be misleading; the wide range underlines the uncertainty of the value[11]. For the monetary analysis, the study uses the low figure to avoid exaggerating the benefits arising from EU directives.[12]

Reduced air pollution accounts for around half of the total benefits. However, it should be kept in mind that the benefits from water and waste directives are less exhaustively captured by the monetary valuation and that the benefits from nature protection are not covered.

At national level, Poland, Turkey, the Czech Republic and Romania stand to benefit from full implementation the most (in absolute terms, see Figure ES.4).

Figure ES.4 - Annual Value of Benefits for Full Compliance: Lower Estimate



The analysis indicates that over half of the benefits that have been estimated in monetary terms are related to the benefits of reduced air (including industrial) pollution. Furthermore the waste benefits assessed are much smaller than those for the air and water related benefits in the lower bound estimate. In the higher bound estimate the benefits from implementing waste related directives is of the same scale as the benefits from the water related directives.

However, it is the case that the benefits assessed for the water and waste directives cover fewer of the actual benefits and therefore the final assessed value is not fully representative of the total benefits

[11] Value of illness, value of early death, cost of global warming are each generally given in large ranges, depending on the method used to estimate them. Similarly, estimates for the value of clear water or clean rivers also tend to be given as ranges.
[12] Given the uncertainties involved, it is of course possible that even this low figure is an overestimate.

likely to accrue from the implementation of the acquis in the environmental domains. Furthermore, it was not possible to assess the benefits from the implementation of the nature related directives, and this clearly does not indicate that there are no benefits.

It is therefore important to underline that fact that the coverage of benefits in the monetary evaluation is lower for waste than for water and lower for water than for air. It is clear that the actual benefits from the implementation of the waste related directives are significantly higher than the monetary value that has been estimated.

Again a simplistic comparison of the benefits value for air, water and waste will lead to misinterpretation of the meaning. The monetary results for each environmental media should be seen in the context of the full range of benefits likely to accrue as given in the qualitative description.

Table ES.6: Annual Benefits of Full Compliance, by Media, by Candidate Country (Million EUR)

Country	***Annual Benefits of Full Compliance (million EUR)***							
	Air		**Water**		**Waste**		**Total**	
	Low	High	Low	High	Low	High	Low	High
Bulgaria	110	1130	160	435	20	680	290	2240
Cyprus	30	140	25	100	8	75	65	310
Czech Republic	730	3600	1560	2475	95	1150	2390	7220
Estonia	40	210	27	100	10	180	75	490
Hungary	590	4100	280	1080	115	1900	985	7080
Latvia	50	320	40	140	5	110	95	570
Lithuania	160	820	125	280	6	205	290	1300
Malta	8	40	13	47	3	40	24	130
Poland	2650	15400	1400	3280	165	2750	4210	21400
Romania	780	5850	405	1250	85	2650	1270	9800
Slovakia	350	2250	305	680	30	440	690	3370
Slovenia	70	475	150	350	25	290	240	1120
Turkey	2180	9700	880	3400	77	1850	3140	14950
Total	**7700**	**44000**	**5380**	**13600**	**650**	**12300**	**12500**	**69300**

Note: Total may not add to the sum of the parts given rounding.

These values relate to the full benefits to the candidate countries - from both own action and as a result of other candidate countries implementing the EU directives, with the exception of Turkey for which only benefits from domestic actions are covered.

It would be misleading to present a single central estimate, as this would implicitly suggest a very accurate knowledge of the relationship between pollutant, impact and monetary benefit. Hence, the lower and upper bounds reflect the bounds of confidence in the results given methodological uncertainties.

Benefits: per capita and per unit GDP

Per Capita Benefits: When looking at these benefits in relation to the population and GDP of the candidate countries, the picture is a little different. The benefits as a proportion of GDP and per capita are summarised in Table ES.7 and Figures E5 and E6 below – for the lower estimate[13] and based on benefits given in purchasing price parities (PPP). The results show the benefits vary significantly between the countries, ranging from 36 to 273 EUR per capita in Bulgaria to 232 to 702 EUR per capita in the Czech Republic.

The range of values across countries reflect several factors – the difference in the actual benefits, variations in data availability allowing benefits estimation, variations in the meaning of data across the candidate countries, and differences in purchasing price parities across countries. For example, the high result in the Czech Republic is strongly influenced by the significant benefits from improvements in river water quality[14]. At the other extreme, the per capita benefits in Bulgaria are relatively small. This is significantly influenced by the far lower PPP ratio for Bulgaria than for example in the Czech Republic or Slovenia. It is important to see the per capita values primarily in the context of national incomes[15].

Benefits as a share of GDP: In terms of GDP, the benefits represent between 0,7% of GDP in Malta and 0,75% in Cyprus to 4,8% of GDP in the Czech Republic. These values indicate the size of the benefits as a proportion of GDP but do not suggest that GDP would rise by a given amount as a result of EU directives[16]. Notwithstanding these variations, the benefits from EU directives are significant for all candidate countries.

It is important to reiterate the fact that these figures correspond to the analysis using the accepted approach of applying PPP weighting factors. The benefits in term of a % of GDP would be significantly higher has no weighting factor been applied. These results should be seen within the methodology context as presented in Parts B on Air, C on Water and D on Waste.

[13] The report tends to present the low results in the summary discussions. If important conclusions can be drawn on the basis of conservative estimates then the implications of a higher estimate is clear.

[14] This in part reflects the length or rivers in the Czech Republic, but also reflects the national system of classification, which might lead to a slightly different classification than in other candidate countries, influencing the Czech result.

[15] For comparisons across countries it is important to keep in mind the role of the PPP inflators. While additional analysis was carried out without weighting for PPP, the results were significantly higher than without the inflators. These results start to make less sense within a national context (basically one would be attributing unrealistic willingness to pay assumptions), despite having the benefit of easier comparison across countries.

[16] There is one main reason for this. The primary reason is that GDP is an indicator of value added to the economy as given by market values, and not all issues we value are represented by GDP – this includes health, long life, appreciation for clean water. In short, GDP is only intended to be an economic indicator, not a full welfare indicator.

Figure ES.5 - Per Capita Annual Benefits from Full Compliance: Lower Estimate

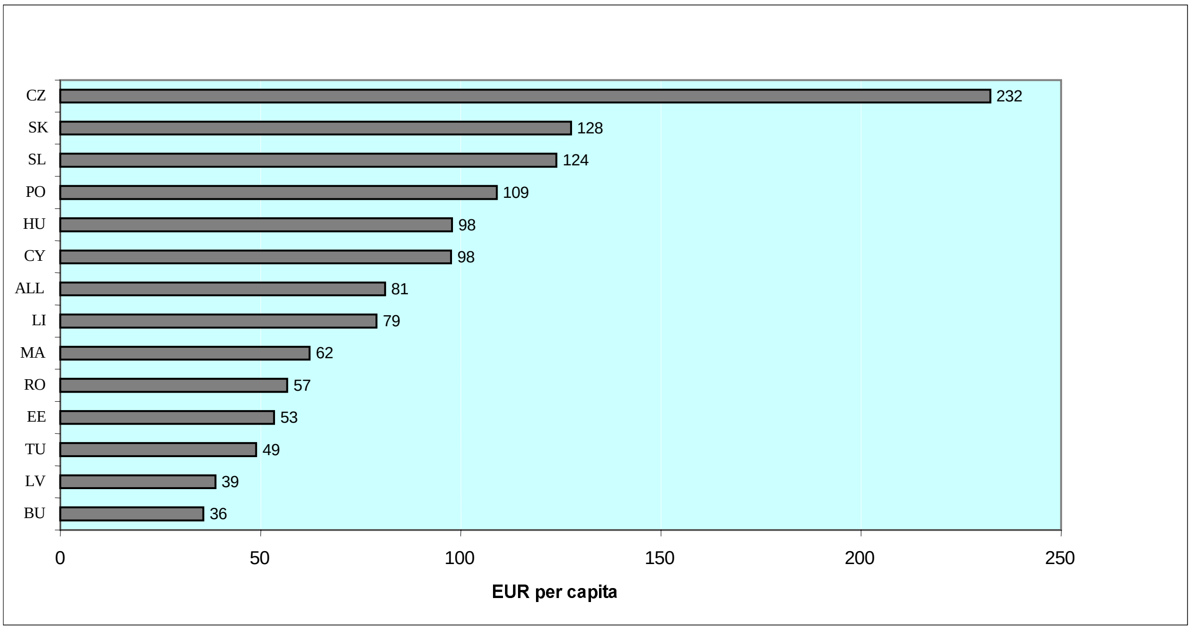


Figure ES.6 - Annual Benefits of Full Compliance as % of GDP: Lower estimate

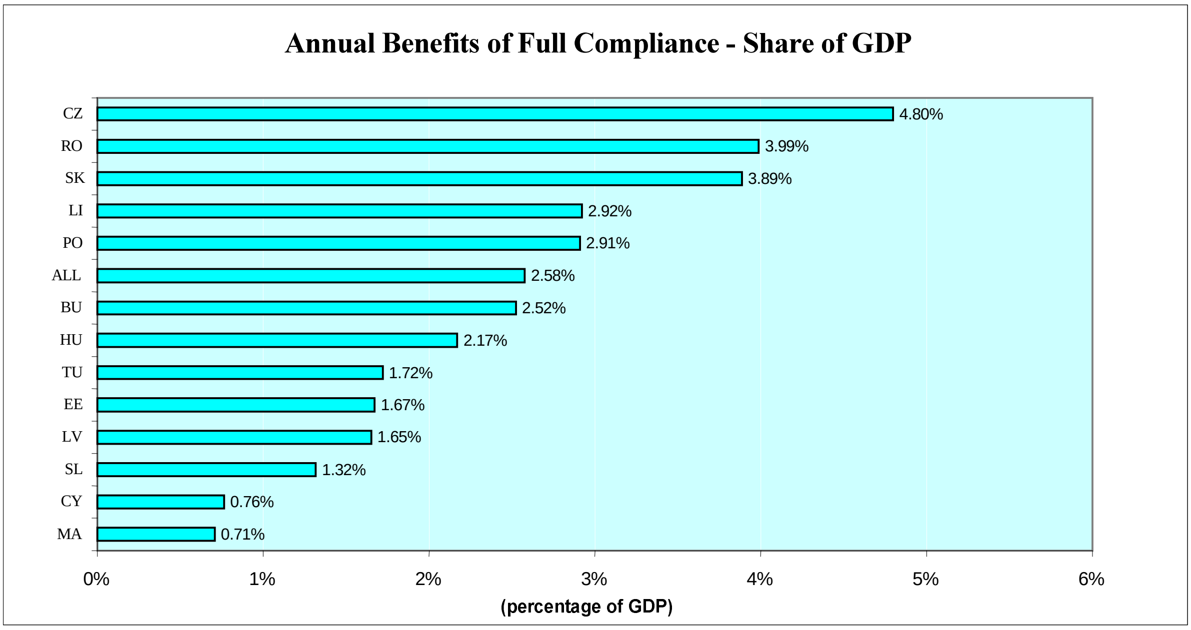


Table ES.7: Annual Benefits of Full Compliance: per Capita & as Percentage of GDP

Candidate Countries	***Ratios of Annual Benefits of Full Compliance***			
	Benefits Per Capita (EUR)		**Benefits as % of GDP**	
	Low	High	Low	High
Bulgaria	36	273	2,5%	19,3%
Cyprus	98	471	0,8%	3,7%
Czech Republic	232	702	4,8%	14,5%
Estonia	53	340	1,7%	10,7%
Hungary	98	703	2,2%	15,6%
Latvia	39	233	1,7%	10,0%
Lithuania	79	353	2,9%	13,1%
Malta	62	329	0,7%	3,7%
Poland	109	553	2,9%	14,8%
Romania	57	436	4,0%	30,7%
Slovakia	128	624	3,9%	19,0%
Slovenia	124	563	1,3%	6,0%
Turkey	49	233	1,7%	8,2%
Total	**81**	**412**	**2,6%**	**13,1%**

Note: It would be misleading to present a single central estimate, as this would implicitly suggest a very accurate knowledge of the relationship between pollutant, impact and monetary benefit. Hence, the lower and upper bounds reflect the bounds of confidence in the results given methodological uncertainties.

Total benefits over the period until 2020

The overall benefits for the candidate countries, over the period 1999-2020, from implementing EU directives amounts to between 134 and 681 billion EUR assuming full implementation is achieved in 2010 (see Table ES.8).

Sensitivity analysis: Sensitivity analysis has been carried out – not just presenting the upper and lower ranges noted above, but also exploring the role of different implementation time periods (2005 and 2020) as well as the effect of different discount rates. The results of this analysis is not presented here in the executive summary as it offers no valuable additional information above the main (expected) conclusions:

- A lower discount rate would lead to a higher total benefits is in the main report. And as a corollary, the total benefit value would be lower with a higher discount rate. This is because, with a higher discount rate, benefits in the future are regarded as being worth less in today's terms.
- The total benefits will increase with early implementation of the acquis communautaire, as the benefits start to accrue earlier and therefore available over a longer period of time (people benefit from clean drinking water for longer). Again, the corollary is clear: a slower implementation would decrease the benefits.

Table ES.8: Total Benefits over the Benefit Period (until 2020), by Media, by Candidate Country

	Present Value (million EUR)							
	Air		**Water**		**Waste**		**Total**	
	Low	High	Low	High	Low	High	Low	High
Bulgaria	1070	11000	1580	4200	195	6620	2850	21800
Cyprus	290	1400	260	960	75	730	630	3050
Czech Republic	7100	35050	15230	24050	925	11200	23260	70300
Estonia	390	2050	260	985	95	1750	750	4780
Hungary	5740	39920	2720	10490	1120	18500	9590	68900
Latvia	485	3120	380	1340	50	1070	915	5500
Lithuania	1555	7980	1230	2750	55	2000	2840	12750
Malta	75	390	125	460	30	390	230	1250
Poland	25800	149930	13590	31960	1600	26300	41000	208200
Romania	7590	56950	3960	12150	825	26300	12380	95400
Slovakia	3400	21900	3000	6610	290	4280	6700	32800
Slovenia	680	4620	1470	3440	240	2820	2400	10900
Turkey	21220	94440	8640	33200	750	18000	30600	145600
All Candidate Countries	75400	428700	52400	132600	6270	112000	134000	681000

(Net Present value over the period until 2020, assuming a 2010 full implementation date for water and air related directives and 2020 full implementation date for waste, and taking a 4% Discount Rate) (Million EUR)

Note: Total may not add to sum of the parts given rounding

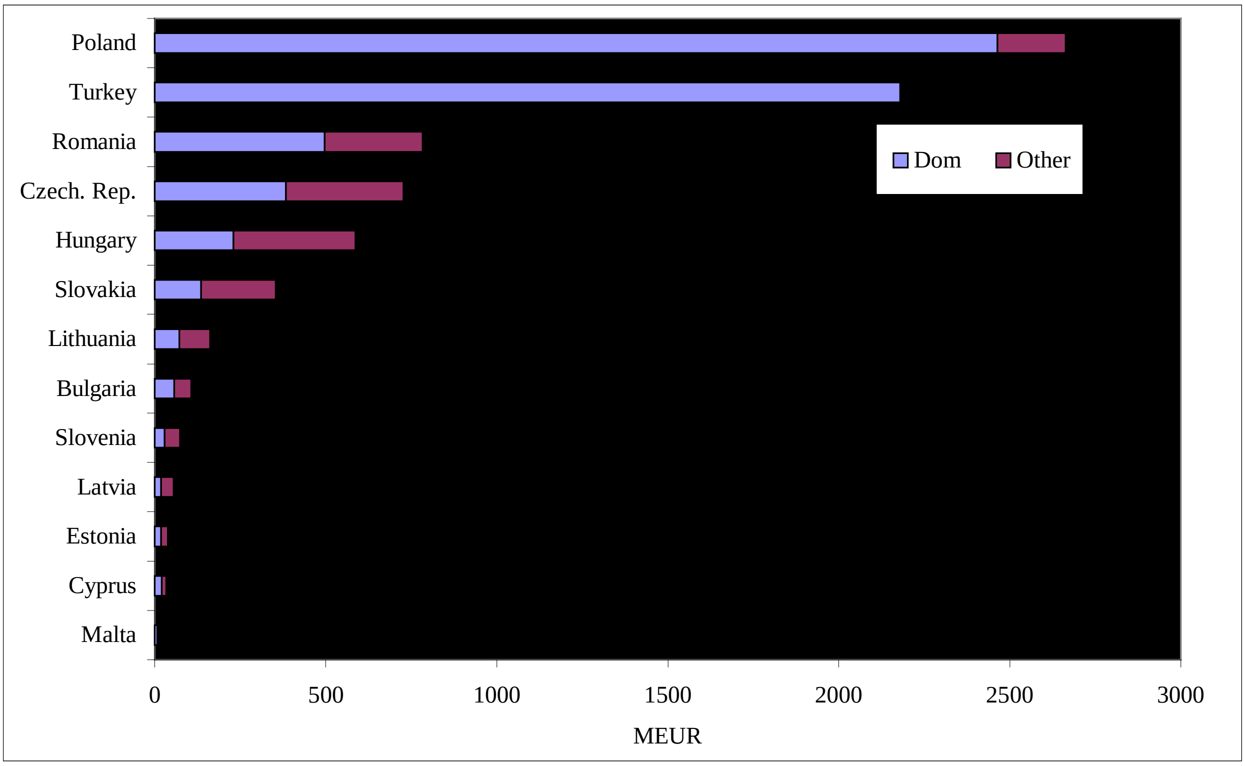
It would be misleading to present a single central estimate, as this would implicitly suggest a very accurate knowledge of the relationship between pollutant, impact and monetary benefit. Hence, the lower and upper bounds reflect the bounds of confidence in the results given methodological uncertainties.

D.4. Value of the benefits: Air

The benefits from reduced mortality, incidence of diseases, damages to building and crops arising from the full implementation of EU directives are estimated to be worth between 8 and 44 billion EUR a year by 2010 for the candidate countries. Poland accounts for about one third of these benefits. There, avoided costs are expected to amount to between 2,7 and 15,5 billion EUR in the year 2010. Figure ES.7 presents an overview of the annual benefits upon full compliance – for the lower estimate.

When taken over the period 1999-2020, the benefits from improved air quality amount to some 75 to 430 billion EUR in net present value terms (recall Table ES.8 above).

Figure ES.7: Total Candidate Country Benefits from Implementing Air related Directives– Benefits from Domestic Action and Benefits from action by other Candidate Countries
(MEUR/year upon full compliance in 2010 - lower estimate)



Note: Benefits to Turkey from other country action have been explicitly excluded as there is a large uncertainty in the estimate, given that the limited data coverage for Turkey in the EcoSense model (see Part B).

Cross border issues

The benefits discussed so far focused on the benefits to the candidate countries. The benefits estimate also offers insights into the relation of benefits in each candidate countries and the actions of all candidate countries, and furthermore the benefits to the EU and third countries from candidate county actions to implement the air related acquis communautaire. Some examples of these transboundary effects are given below:

- Benefits for the candidate countries resulting from reduced air pollution from other candidate countries through their implementation of EU directives amount to 1,7 billion EUR annually, according to the low estimate[17] (see Figure ES.7 above).
- Some candidate countries benefit significantly from the actions of other candidate countries to implement the acquis. In Hungary, for example, half of the total benefits result from action by other candidate countries.
- As a corollary to the last point, domestic actions can lead to very significant benefits to neighbouring countries. In some cases, foreign benefits are several times larger than the domestic benefits from domestic action. For example, Polish initiatives for complying with EU air

[17] Turkey not included.

directives will lead to between 2,5 and 11,8 billion EUR in benefits for Poland but between 4,1 and 24 billion EUR in benefits to other countries combined.

- The EU would benefit significantly from lower emissions of air pollutants from the candidate countries and their implementation of EU directives. This would amount to 6,5 billion EUR annually according to the low estimate. As an example, the EU benefits between 1.7 to 10 billion EUR per year from Polish compliance with EU air directives.
- The total benefits accruing to non-EU third countries (notably Ukraine, Belarus and Russia) from actions by the candidate countries to meet the requirements of EU directives would stand at 9.5 billion EUR per year, again applying the low estimate.

These figures underline the benefits for the whole of Europe from the accession of the candidate countries to the EU and their implementation of EU environmental directives.

Role of specific pollutants

The benefits arise primarily from lower emissions of particulates, the acidic pollutants SO2 and NOx, volatile organic compounds (VOCs) and ammonia (NH3). The reductions in these five pollutants account for over 95% of the value of total benefits for the lower estimate. Reductions in carbon monoxide (CO) and carbon dioxide (CO2) account for a very small fraction of the total benefits[18]. It should be noted, however, that the very low values for CO are a consequence of the lack of clear data of its impact on health. However, these are increasingly recognised to be significant and the benefits are therefore likely to be underestimated. For CO_2, there is similarly a growing awareness of the possible extent of these impacts, but also a lack of data. The importance of these two pollutants is therefore expected to grow in future studies. Other pollutants not assessed here, but which are known to be important, include: ozone in urban areas and dioxin emissions.

Role of Specific Directives

For the air sector, the benefits from different directives cannot be separated sensibly, given the inter-linkages of the directives, and hence this chapter of the environmental acquis has been dealt with as a “bundle of directives”. For example, it is clear that the LCPD, IPPC directive, the Air Framework Directive and daughters and the fuel quality directives all contribute significantly to reductions in SO2 and NOx emissions.

D.5. Value of Benefits: Water

Drinking Water

Cleaner drinking water resulting from EU water directives has an estimated value of 500 million to 8,7 billion EUR a year upon full implementation. This is based on the overall demand for clean drinking water. The demand in Turkey accounts for around a third of the total value (150 to 2.650 million EUR a year). Given the assumptions behind the lower and upper estimates (See Part C), it is likely that the upper estimate is more representative of the true benefits than the lower.

[18] The benefits from CO2 are larger as a share of the total benefits under the upper estimate, given that the range of benefits for CO2 is wider than for other pollutants given the greater scientific uncertainty as to the impacts and their costs of global warming.

Bathing and other surface water quality

The benefits from a better quality of bathing water are estimated at around 2,5 billion EUR a year. Similarly, this is based on the demand for clean bathing water.

Improved river quality

The willingness to pay for an improvement of river quality from ‘poor’ to ‘fair’ and from ‘fair’ to ‘good’ is estimated at 2 billion EUR a year across the candidate countries. This estimate excludes the benefits from direct use, for instance for recreation; this ensures there is no double counting with the above estimates for bathing and surface water benefits. The Czech Republic accounts for more than half of this sum, or 1.2 billion EUR a year. The importance of the Czech figure relates to the fact that data has not been available for an estimate for some countries (hence the high share of the Czech Republic), and secondly the combination of the length of rivers (the CR has the greatest length of rivers among the candidate countries), relatively high PPP, expected river quality improvements and the river quality classification system lead to the particularly high value in the Czech Republic.

Total Value of Benefits

The total value of the benefits from implementing EU water directives across the candidate countries lies in the range of 5 to 14 billion EUR a year (lower and upper estimates respectively). As noted above, the study team feels that the higher estimate is actually more representative of the real benefits than the lower estimate. A summary is presented in Figures E8 and E9, with details presented in Part C.

Figure ES.8: Annual Benefits of Full Compliance with Water Directives: Lower Estimate

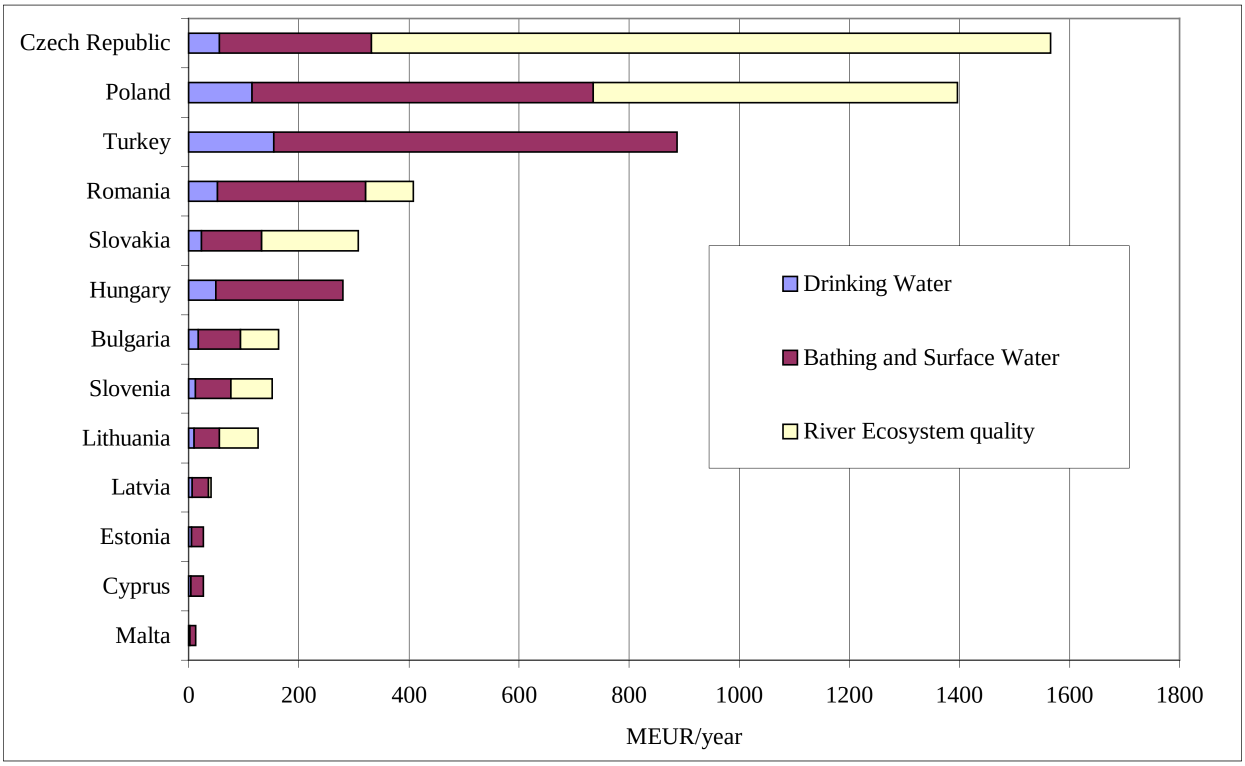
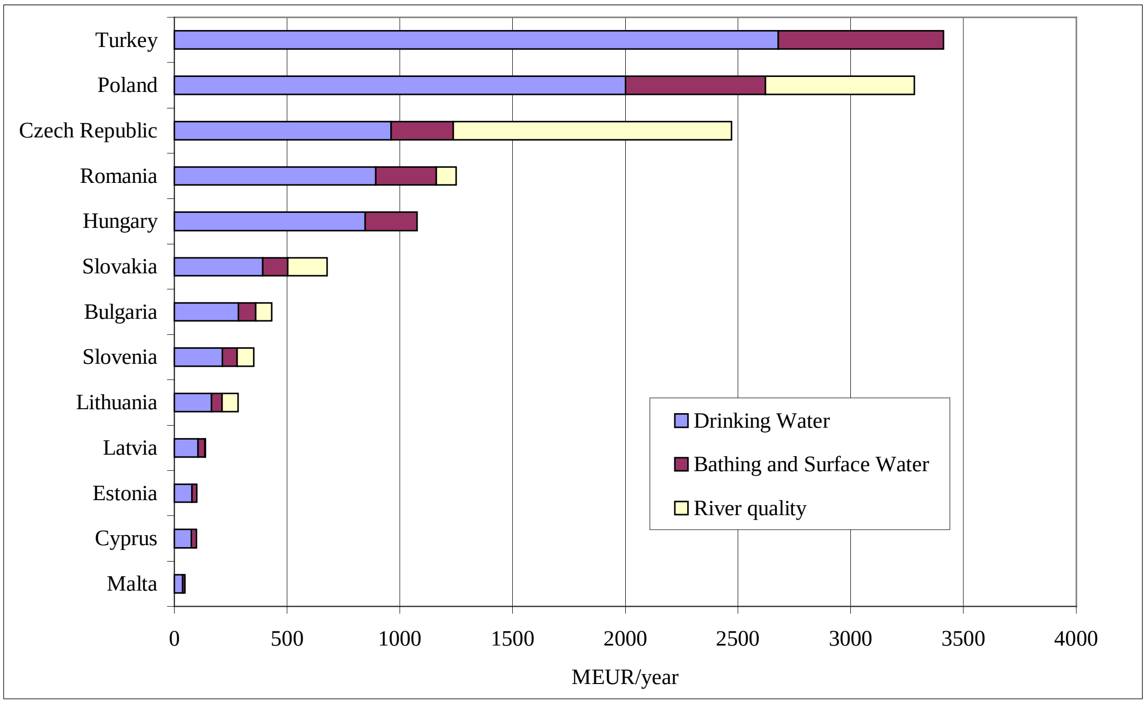


Figure ES.9: Annual Benefits of Full Compliance: Upper Estimate



D.6. Value of benefits: Waste

Aggregate Benefits

The value of the benefits from EU waste directives (directives on Landfill and Packaging Waste) has been estimated for all candidate countries. The Landfill Directives is particular important and has been assessed using two scenarios, one with a maximum level of recycling/composting and the other with a maximum level of incineration, giving benefits with a lower and a higher bound for each scenario.

The total annual benefits from full compliance with the Landfill and Packaging Directives were estimated to be higher under the scenario with a maximum level of recycling. In this case, they range from 1,3 to 12,3 billion EUR a year. Under the scenario with maximum incineration, the benefits stand at some 0,6 to 8,7 billion EUR a year. Across all scenarios, benefits from EU waste directives range at 0,6 to 12,3 billion EUR a year. The implementation of the Landfill Directive contributes with the largest share of these benefits from waste directives.

Landfill Directive

For all of the candidate countries, complying with the Landfill Directive by adopting a maximum level of recycling should lead to larger benefits than maximising incineration. Benefits for all countries amount to between 1,1 and 10,9 billion EUR a year for the recycling scenario against 0,4 to 7,3 billion EUR a year for incineration. This underlines the importance of the choice of the implementation pathway for a directive and the influence that the implementation strategy can have on the benefits. In reality, the candidate countries are likely to adopt some sort of middle ground between the two extreme scenarios of maximum recycling and maximum incineration, with some focussing more on recycling and composting and others with greater reliance on incineration.

At the country level, the highest annual benefits accrue to Hungary (0,15 to 1,7 billion EUR), Poland (0,25 to 2,5 billion EUR) and Romania (0,2 to 2,6 billion EUR).

Packaging Directive

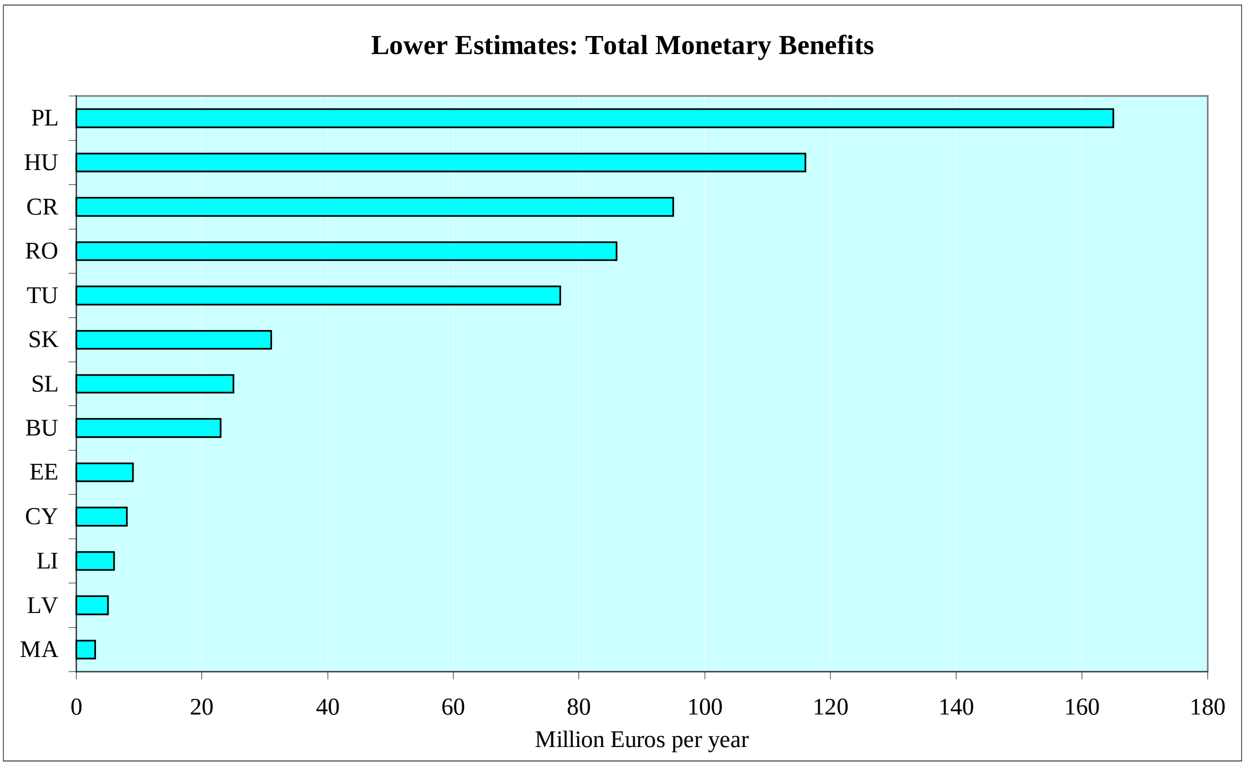
Total benefits from the Packaging Directive range from 156 to 910 million EUR a year for all candidate countries taken together. This relates to the benefits from avoided environmental damage by using secondary materials (e.g. recycled paper, aluminium and glass) instead of more primary materials. The largest annual benefits are experienced by Hungary (10-107 million EUR), Poland (35-191 Million EUR) and the Czech Republic (22-148 million EUR).

Incineration Directive (Czech Republic only)

Incineration gives lower benefits. This is clearly illustrated by the example of the Czech Republic for which benefits from complying with the EU incineration directives ranges from 3 to 22 million EUR a year. This is only around 13% of the Czech Republic's benefits from the Packaging Directive.

The total benefits for the implementation of the waste Directives are depicted in Figure ES.10 – for the lower estimate. See Part D for further details.

Figure ES.10 Total Annual Monetised Benefits from Compliance: Lower Estimates



E. INTERPRETATION OF RESULTS

The authors do not pretend that the monetary estimate for the benefits is the final measure of benefits. The monetary benefits analysis is therefore focused on that audience that will be able to use the monetary analysis to gain a deeper appreciation of the scale of the benefits likely to accrue from implementing the national legislation compliant with the EU acquis communautaire.

Types of Benefits

The estimate of total benefits is based on an analysis of the changes in pollution attributable to compliance with the Directives and the effects on ‘receptors’ (e.g. health of people, the amenity value of the environment, the repair of buildings and the productivity of natural resources). These damage cost savings are therefore built up from the benefits from given unit reductions in specified pollutants, or from the assumed willingness to pay (WTP) of people for specified improvements in health, recreation and amenity value.

The analysis indicates that for the subset of benefits that can be measured in monetary terms, over 80% of the benefits relate to the improved health of people resulting from reduced pollution (especially of air pollutants). The measurement of health benefits needs to be understood in the context of the continuing debates about how to value the benefits from the changes in risks to life expectancy, and whether such values should reflect national income (as mentioned above in footnote 11). The lower estimates of benefits takes a conservative view (in terms of the scale of benefits) of both of these issues – in the former case looking at the lower bounds of risk/impacts and in the latter, using national purchasing power indicators.

The benefits from full compliance also comprise non-monetary benefits, especially the protection of sensitive ecosystems and biodiversity, and non-environmental benefits, especially the boost to economic activity from the related construction and operation of environmental infrastructure required by compliance programmes. In the case of nature conservation, full compliance with provisions would secure protection of many thousand hectares of valuable habitats and hundreds of endangered species from the threats of social and economic activity, much of which is expected to grow as a consequence of accession. Economic benefits include the support of employment and increased economic efficiency.

The relative importance of different media

A simplistic focus on the final benefits results presented in monetary terms would suggest that the benefits from the implementation are significant lower than from the water directives, which in turn are lower than the benefits from the implementation of the air related directives. Such a conclusion would be erroneous and unhelpful. As stated earlier, the coverage of issues that can be monetised varies significantly across directives and media. Existing scientific literature is more advanced on the analysis of air pollution impacts than on the analysis of water-based impacts, which in turn is more advanced than the science on waste related impacts. It is clear that the waste numbers significantly underestimate to the total benefits (See Part D for further discussion). It is therefore doubly important that any interest in the benefits from the implementation of the acquis communautaire focus equally on the qualitiative assessment (see chapters 1 in the Part B on Air, Part C on Water, Part D on Waste and Part E on Nature), as on the quantitative assessment or the monetary analysis, and to see the quantitative and monetary estimates in the appropriate context of what they have been able to cover given scientific knowledge and data availability.

The Relative Contribution to Benefits of Different Directives

The purpose of the analysis is not only to understand the overall benefits associated with implementing the acquis, but also to understand, to the extent possible, the role of particular directives[19] in leading to these benefits. In the case of directives related to waste management, a directive specific approach has been able to have been taken, but not all the relevant waste Directives have been assessed. In the case of air pollution, the reduction in specified pollutants will be determined by the joint influence of a number of the Directives, and hence their benefits have been assessed as a "bundle of Directives" In the case of water, only benefits at an aggregate level have been defined – for example where benefits of improvements of water quality can be assessed, but a number of different directives (both down stream quality directives and upstream emissions related directives) contribute to the quality. It is therefore extremely difficult to attribute shares of the estimated benefits to individual Directives. Some disaggregation has been possible (see Part C), but several directives lead to the benefits.

Even if it were possible, there is strong case for suggesting that such a breakdown is unnecessary. This is because of the inter-relation between the different directives of the environmental acquis – the implementation of down-stream quality standard related directives would only lead to full benefits if upstream directives were implemented in parallel. For examples, the bathing waters directive cannot sensibly be implemented without also implementing the Discharge of Dangerous Substances to the aquatic environment directive and the Urban Waste Water Treatment Directive. Furthermore, many investment projects address more than one directive at once, and in some cases it makes little sense to have directive specific projects.

If the political process requires such a breakdown of benefits, one could point to the fact that over half of the subset of benefits measured in monetary terms derives from reductions in air pollution (including industrial pollution control). However, it is the case that the benefits from water and waste Directives are less exhaustively captured by the monetary analysis, and that the benefits from nature protection are absent entirely. Moreover, in terms of non-environmental benefits, compliance with non-air directives, especially waste related, are likely to be higher because of the commercial opportunities provided by, and the labour intensity of, the compliance programmes.

[19] The analysis has not sought to assess the benefits resulting from a specific requirement of a directive, nor assess the marginal benefits that accrue as the directive is increasingly implemented (e.g. for the different agglomeration size targets for the Urban Waste Water Treatment Directive, or the staged targets to reduce waste to landfill in (Article 5 of) the Landfill directive. Instead, we have focused on assessing the aggregate benefits and not reopening a debate on which bits of the Directive are most valuable.

Attribution of benefits might be helpful if some of the investment heavy directives were considered to provide only limited contribution to the benefits. However, it is extremely difficult to argue, given the nature of the benefits, that this is the case. Rather it argues for a focus on designing the most cost-effective *integrated* programme of compliance, at least across a sector (air, water, waste, nature etc). The analysis in this study provides a major starting point for this work.

F. SUMMARY

F.1. Summary Conclusions

This study has highlighted and assessed the range of benefits that the implementation of EU environmental directives will bring to the candidate countries. The key results show that:

- There are very significant benefits to be gained by all candidate countries from fully implementing EU directives. For example, fully implementing the EU directives related to air quality can lead to between 15.000 and 34.000 fewer cases per year of premature deaths from exposure to air pollution, and between 43.000 and 180.000 fewer cases of chronic bronchitis.
- When taken all together, the annual value of these benefits ranges between 12 and 69 billion EUR. This corresponds to between 80 and 410 EUR per capita. Over the time period until 2020, the cumulative benefits amount to between 134 and 681 billion EUR. Given all uncertainties with these figures, it is important, to take the lower figure in this range as the main result of the study. Even when the lower figure is used, the study clearly suggests that the value of benefits is significant and that the importance of the benefits could usefully be explored in more detail for key decisions in the candidate countries.
- Improved air quality, resulting from the implementation of EU directives, accounts for around 55% of the total value of these benefits. The benefits from reducing air pollution relate mainly to improved public health through fewer respiratory diseases and, most importantly, fewer cases of premature deaths. There are also significant benefits from a reduced burden on agricultural crops and avoided damages to buildings.
- The benefits of EU directives do not only accrue to the candidate countries. Reductions in trans-boundary air pollution will yield significant cross-border and trans-national benefits. The main results are:[20]
    - Benefits from domestic actions amount to around 6 billion EUR a year upon full compliance. Domestic benefits from actions by other candidate country add a further 1.7 billion EUR.[21]
    - Total benefits from actions by the candidate country for other countries amount to 16 billion EUR a year. The EU Member States benefit 6.5 billion EUR and other countries, notably the Ukraine, Belarus and Russia, some 9.5 billion EUR a year.
    - Overall the benefits of candidate country implementation of the acquis will lead to as many benefits outside the candidate countries as within the candidate countries.
- The benefits from implementing the EU's water related directives include improved access to clean drinking water, bathing water and rivers. Up to 59 million households could benefit from improved drinking water quality, and 10 million households are expected to benefit from new connection to drinking water. River quality will improve, for example with the number of "good"

[20] All applying the lower estimate of benefits.
[21] Turkey not included.

quality rivers more than doubling in Bulgaria. The value of these benefits, together with benefits of increased recreation from cleaner surface waters, amount to around 5 to 14 billion EUR a year.

- The benefits from implementing EU waste directives include reduced methane emissions, which benefit public health and global warming and a reduced impact on the environment through increased recycling and the lower use of primary materials. The level of recycling from the Packaging Directive is likely to increase by around 3,7 million tonnes – or on average around 22 kg per capita. In addition, implementing the Landfill Directive (under the maximum recycling and composting scenario) will lead to around 54 million tonnes of diverted bio-degradable waste being recycled or composted by 2020. The reduction in methane emissions should be between 1 and 6 million tonnes per year. The value of the waste related benefits ranges from 1 to 12 billion EUR a year, with the benefits likely to be higher under the maximum recycling scenario than under the incineration scenario.
- In the case of nature conservation, EU directives would secure protection of many thousand hectares of valuable habitats and hundreds of endangered species, especially endemic species.
- In addition, the expenditure on environmental goods and services will help develop the eco-industry sector of the economies and support significant jobs within this sector. The order of magnitude estimate derived here suggest that up to 1.8 million jobs could be supported at any given time, of which around 0.5 million would stem from capital expenditure and the remaining 1.3 million from the provision of environmental services and from the operation and maintenance of environmental infrastructure.

In addition, many benefits of EU directives have not been fully covered when assessing the monetary values. This includes the protection of sensitive ecosystems and bio-diversity. Some environmental investments might also lead to benefits not directly related to the environment. They can improve economic efficiency and boost productivity, for example by facilitating the take-up of modern technology, by lowering production and maintenance costs for companies through better water quality and by providing savings in the form of more efficient waste management.

From this range of benefits, three key conclusions can be drawn:

- Implementing the EU environmental directives can help ***improve the health and quality of life for citizens*** across the candidate countries, and to a certain extent, for citizens of the EU.
- ***Co-operation across candidate countries*** is crucial to maximise the transboundary benefits from reducing air pollution.
- In narrow monetary terms, the assessed ***benefits are likely to be of the same order of magnitude if not larger than the costs*** of implementing EU directives. However, this result should be treated with extreme caution, as there is considerable uncertainty for estimates both of benefits and costs.

F.2. Interpretation of results

The study does not suggest that the money value for the benefits of EU directives is the final measure of these benefits. Nor do the authors mean to imply that these benefits can really be equated to money, but rather it is an indicator of importance of the benefits. There are significant ethical and methodological concerns that should be taken into account.

The ethical concern is clear: Some object as a matter of principle to giving illness, life and damage to eco-systems an economic value. A general response is that people naturally make trade-offs between the environment and their economies. The aim of the monetary value is to identify the choice that people (and government & industry) want, and to demonstrate that there are real benefits to be had from implementing EU directives in the candidate countries.

The methodological concern is also clear: only some benefits have been taken into account; there are data limitations, difficulties in assessing future economic growth and increasing environmental pressures, and also limitations of the methods used. This underlines the fact that:

- For the monetary analysis, no single figure can be given, and that broad ranges are needed for an honest analysis. However, the meaning of the range can be taken seriously, although the reader should be aware that the true value might be outside the range given here.
- The monetary analysis needs to be seen side by side with the qualitative analysis, which presents insights on a wider range of benefit than could be taken into account in the monetary analysis. The monetary analysis should not be seen as the only end point of the study.

The study has drawn upon the latest scientific literature, evaluation models, scientific literature, and the latest available data from across the candidate countries and evidence from wider afield on the benefits of implementing the acquis. This would therefore suggest that in the foreseeable future it is unlikely that a more comprehensive analysis of benefits would be available for the breadth of coverage of countries and directives (see F4 for possible next steps). While every effort has been made to recognise and take account of uncertainties, these do not diminish the clear evidence that indicates that there are major environmental and economic benefits from the implementation of the environmental acquis communautaire by the candidate countries.

F.3. Policy Recommendations

The results and discussion above have a number of implications for the environmental policy of the candidate countries in the context of their accession to the EU.

i) The benefits assessment suggests that there could be significant benefits from EU environmental directives that have not always been fully taken into account when taking decisions on transposing and implementing these directives. The scale of the benefits suggests that this aspect should be integrated into decisions on implementation planning. This may lead to the conclusion that the candidate countries' current efforts for implementing EU environmental directives should be maintained, if not strengthened.

ii) The total benefits resulting from EU directives are higher if their implementation is accelerated. This is because the benefits would start to accrue earlier given earlier reductions in emissions, improvements in air and water quality and waste management practices. Clearly an accelerated investment programme would also lead to the costs of compliance being higher[22]. However, the increase in benefits would be larger than the increase in compliance costs under an accelerated compliance programme.

iii) The benefits are not confined to specific elements of the environmental legislation, the full set of directives is important in generating benefits. The inter-relations between directives are strong and the implementation of several of them is needed to ensure full benefits. The implementation plans could valuably reflect this by ensuring that all directives are looked at and that the dangers of prioritising only a small subset of directives are avoided.

iv) While it is, in principle, possible to do broad cost-benefits analyses of EU directives, the implementation programmes should ensure that they are not only driven by such considerations because this might exclude other equally important issues that are difficult to quantify in monetary terms. This includes, among others, many important social benefits such as bio-diversity. The monetary assessment should be taken as a strong indicator and a tool. However, other types of benefits should also be given due consideration.

v) The environmental benefits will be enhanced if the implementation of other policy areas such as agriculture, transport and energy takes into account environmental concerns and integrates the principle of sustainable development. Similarly, the implementation of the other policy areas could usefully take on board the knowledge of the likely benefits associated with environmental measures.

In short, this analysis, by highlighting, assessing and valuing the benefits of compliance with the body of EU environmental directives has demonstrated the interest to the candidate countries and to the EU of ensuring that the environmental legislation is given the priority it deserves.

F.4. Possible Further Applications of the Benefits Valuation Approach

The study analysis has focused on all thirteen candidate countries and most of the main directives. This has implied that the analysis on any specific country or specific directive has not always been as in-depth as could have been wished. Nevertheless, the study team feel that the study offers a good

[22] Early investment to comply with the acquis will lead to more years of operation and maintenance costs. However, there will be no effective change to the size of investment costs, with the exception of the opportunity cost of money. On the other hand, early compliance will lead to additional years worth of full benefits. The relative increase in benefits will be larger than the increase in the costs, assuming reasonable cost of capital.

overview picture of the scale and nature of the benefits that are likely to accrue from the full implementation of the environmental acquis communautaire in the candidate countries. To take such analysis further and to allow for a greater depth, the following could be valuable:

- An in-depth analysis of the benefits to a particular locality – such as a municipality – which could help in the further development local sustainable development action plans;
- A regional approach – focussing on a river basin for example.
- An analysis on a protected area or bathing area of potential tourist value to help clarify the potential opportunities of (eco) tourism which could subsequently create an improved rationale for the safeguard of sensitive areas.
- A media specific or even directive specific focus, though taking into account the inter-linkages to other directives.
- An evaluation of the benefits of investment programmes, whether national or international.
- Benefits valuation linked to new infrastructure and hence use to clarify pricing policy and the timescale of moving towards, where appropriate, full cost recovery systems.
- Incorporation of a broader benefits assessment into EIAs or project selection; and, if carried out during project design will lead to improved benefits.
- Finally, a benefits assessment could be usefully incorporated into a broader sustainable development assessment, which can help contribute to a move towards a sustainable (development) growth path.

These steps could therefore allow additional insights to be obtained into the benefits of policies, programmes and investments and support the process of ensuring that the greatest benefits can be achieved from the implementation of the acquis communautaire in the candidate countries.

THE BENEFITS OF COMPLIANCE WITH THE ENVIRONMENTAL ACQUIS FOR THE CANDIDATE COUNTRIES

DGENV Contract: Environmental Policy in the Candidate Countries and their Preparations for Accession

Service Contract B7-8110 / 2000 / 159960 / MAR / H1

Final Report

July 2001

THE BENEFITS OF COMPLIANCE WITH THE ENVIRONMENTAL ACQUIS FOR THE CANDIDATE COUNTRIES

Final Report

PART A: MAIN REPORT

1.0 INTRODUCTION

1.1 This Report

This is the Final Report of the sub-study assignment request No. 3 on the ***Benefits of Compliance with the Environmental Acquis for the Candidate Countries***, as part of the DGENV contract on ***Environmental Policy in the Candidate Countries and their Preparations for Accession***, Service Contract B7-8110 / 2000 / 159960 / MAR / H1.

The report presents the results and conclusions of the assessment of benefits accruing to the candidate countries from their implementation of the directives specified by the environmental chapter of the *Acquis Communautaire*.

The overall report is structured into six parts:

- ❒ **Part A:** Introduces the **objectives and scope** of work, the **study context**, describes the **method of approach** and presents the **main results** and **conclusions** from the benefits assessment.
- ❒ **Part B:** Presents the assessment for **air** related directives.
- ❒ **Part C:** Presents the assessment for the **water** related directives.
- ❒ **Part D:** Presents the assessment for the **waste** related directives.
- ❒ **Part E:** Presents the assessment for the **nature protection** directives.
- ❒ **Part F:** Presents the assessment of the socio-economic benefits, focusing primarily on the **employment effects** from implementing the provisions of the directives.

The key results of Parts B to F are presented in the main report – Part A. The Parts B to F contain more detailed results, including an important and extensive discussion of the type of benefits arising from implementation the directives and country specific examples. They also contain explanations of the methodologies adopted, analysis assumptions, and references for the sources of data, methods and other studies of relevance. Given the nature of a benefits valuation, and the need to show a transparent and clearly defined and defensible approach in such an exercise, these discussions on methodology can be quite involved. To the extent possible, details have been included in annexes to the main text in each Part.

Each Part of the report, with related Annexes, is a separate electronic file to allow ease of use. In addition, an Executive Summary is included as a separate electronic file.

1.2 Objectives of the Study

The purpose of the study is to assess the range and scale of benefits (see Box A.1) accruing to the candidate countries from their implementation of the EU environmental acquis. Specific objectives are to:

1. Briefly review which directives face the largest compliance gaps. This will help to clarify where additional information on benefits is especially relevant in the context of decisions on the implementation of the directive concerned.
2. Qualitatively review the full range of effects (environmental and non-environmental) of the implementation of a wide set of key environmental directives. In addition, identify key variations between the 13 candidate countries and those benefits of particular importance to individual candidate countries.
3. Examine for a sub-set of effects (environmental and non-environmental), the quantitative (but non-monetised) benefits of implementation. Environmental effects are expressed in physical terms (e.g. change in pollution, receptors). Non-environmental effects, especially employment, are also considered.
4. Estimate, where possible for selected physical environmental benefits, the range of monetary values arising from the implementation of EU directives, by country, of selected directives or groups of directives.

Box 1: "Benefits" of Compliance - Clarification of Definition

The implementation of the environmental acquis communautaire in the candidate countries will lead to a wide range of benefits, including health benefits, eco-system benefits, and broader benefits such as benefits to natural resources (e.g. fisheries or agriculture), social benefits and also wider economic benefits (e.g. attracting tourism or eco-efficiency gains). These are presented in detail in Chapter 3.

It is, however, important to clarify up front what we mean by benefits and how we calculate them. Many of the benefits discussed in this report are in fact **avoided damage**. This is the case notably for health benefits and other environmental benefits such as eco-system benefits. In other words, the benefit is calculated on the basis of understanding what the impact or level of damage is and how this will be reduced with the proper implementation of the acquis. This leads to estimates for reductions in the incidence of respiratory diseases for example, the reduction in the number of poor quality rivers, or the reduction in agricultural losses from pollution deposition.

Other benefits are more "common sense" benefits, i.e. where the implementation of the acquis leads to actual improvements rather than just a reduction of damage. For example, the social benefits of increased learning and awareness of environmental impacts and increased involvement in solving environmental problems is this type of benefit. Another example is the issue of improved access to clean drinking water.

The full range of benefits types, examples, assessments and methodologies are presented in more detail in Chapter 3 and 4 of this Part A, and throughout Parts B, C, D, E and F.

The study aim is that the insights gained from the above steps should identify and highlight any significant benefits likely to accrue from implementing the environmental acquis and that the insights should contribute to the continued development of policy, prioritisation and approach to addressing environmental issue in the accession process

It should also be underlined that the aim of the study was not to carry out in-depth analysis of particular candidate countries; this was beyond the scope of the study. Nor was it the objective of the study to develop a perfect assessment of the benefits of particular directives that are accurate to one decimal place and statistically defensible. This was again outside the scope of the study, and arguably methodologically impossible (see Chapter 3 and Parts B-F).

1.3 Scope of Work

The sub-study covers all the 13 candidate countries, a wide range of key environmental directives (but at different levels of analysis). Where possible all candidate countries are included in the directive benefits analysis; data availability has, however, led to more comprehensive analysis for some countries than for others.

Table A.1 presents the environmental directives covered by the study, and the level of analysis that has been possible for each of the directives. It is important to note that the selection does not suggest that there are no or only marginal benefits from the proper implementation of other directives not covered (see chapter 3).

The analysis has sought to carry out three levels of analysis, with the level of analysis depending mainly on the availability of data and scientifically robust methodologies for carrying out the quantitative and monetary assessments:

- Level 1: The type of benefits – the **qualitative assessment** of the range (environmental and non-environmental) of benefits;
- Level 2: The extent of the benefits; in other words a **quantitative**, but non-monetary, **assessment** of benefits;
- Step 3: The value of the benefits; in other words, the **monetary estimate** of the benefits of compliance.

Whilst it was the intention is to provide as much information as possible on a directive-by-directive basis, the quantification of effects on a directive-specific basis is difficult; and there are limits to the extent that effects can be attributed to individual directives. In some cases the benefits of the directives are only attributable to a group or “bundle” of directives. This issue is discussed further in Chapter 3.

Table A1: The Acquis Communautaire, and Level of Analysis

Directive		Level of Analysis
A. Horizontal		Not estimated
EIA	85/337, amen. 97/11/EC	Not estimated
Access to information	90/313	Not estimated
Implementation Reports	91/692	Not estimated
Regulation – LIFE	1973/92. Amen	Not estimated
B. Air Quality		Monetary assessment
Air Quality Frame. + daughters: PM10, SO2, lead, N20	96/62, 80/779,amen,	Monetary assessment
Tropospheric Ozone Pollution	92/72	Qualitative analysis
Emissions from motor vehicles, diesel engines, soot, etc	70/220, amen. etc	Qualitative analysis
VOC emissions from storage and transport of petrol	94/63	Qualitative analysis
Lead content of petrol, quality of diesel, sulphur content.	85/210, amen. etc	Qualitative analysis
Emissions from non-road mobile machinery	97/68	Qualitative analysis
Regulation – Ozone Depleting Substances	EC/3093/94	General description
C. Waste Management		Monetary assessment
Framework Directive on Waste	75/442/EEC+ 91/156/EEC and 96/350/EC	Qualitative analysis
Titanium Dioxide + daughters	78/176, am. 82/883, 92/112 etc.	General description
Air pollution: incineration of waste	2000/76/EC replacing. 89/369/EEC, 89/429/EEC, 94/67/EC	Monetary assessment
Landfill	1999/31/EC	Monetary assessment
Disposal of Waste oils	75/439, amen. 87/101/EEC	Qualitative analysis
Disposal of PCBs and PCTs	76/403/EEC amen 96/59	Qualitative analysis
Hazardous Waste	91/689, amen. 94/31/EC	Qualitative analysis
Sewage Sludge and Soil	86/278, amen.	Qualitative analysis
Batteries and Accumulators	91/157, amen. 93/86/EEC	Qualitative analysis
Packaging waste	94/62, amen. 97/129/EC	Monetary assessment
Toxic and Dangerous Waste	78/319/EEC	Qualitative analysis
Animal Waste	90/425/EEC, 90/667/EEC	Qualitative analysis
Control of Transboundary Movements of Haz. Waste and their Disposal (Basle Convention)	93/98/EEC	Qualitative analysis
Supervision and Control of Shipments of Waste	94/575/EC, 94/774/EEC, 96/660/EC	Qualitative analysis
Hazardous Waste List	94/904/EC	Not estimated
European Waste Catalogue	94/3/EC	Not estimated
Regulation – Shipment of Waste	EEC/259/93.	Not estimated
D. Water Quality		Monetary assessment
Water Quality Framework	2000/60/EC	Qualitative analysis
Dangerous Substances to aquatic environment	76/464, amen. etc	Monetary assessment: implicitly
Urban waste water	91/271, amen.	Monetary assessment:

Directive		Level of Analysis
		implicitly
Nitrates	91/676	Monetary assessment: implicitly
Bathing Water	76/160	Monetary assessment
Drinking Water	80/778, amen.	Monetary assessment: explicitly
Surface Water for drinking	75/440, amen.	Qualitative analysis
Measurement sampling of drinking water	79/869, amen.	Not estimated
Ground water	80/68, amen.	Qualitative analysis
Fish water	78/659, amen.	Qualitative analysis
Shellfish Waters	79/923, amen.	Qualitative analysis
E. Nature Protection		Qualitative analysis
Habitats	92/43, amen.	Quantitative analysis
Wild Birds	79/409, amen.	Part of Habitats
Seal Skins	83/129, amen.	Not estimated
F. Industrial Pollution Control		
Air Pollution from Industrial Plants	84/360, amen.	Monetary assessment
Large Combustion Plants	88/609, amen.	Monetary assessment
IPPC	96/61	Monetary assessment
Seveso - Control of Major Accident Hazards	96/82, amen.	Qualitative analysis
Industrial pollution: reduction of emissions of volatile organic compounds (VOC)	1999/13/CE	Monetary assessment
Regulation – Community eco-label award scheme	880/92 & 1836/93	General description
G. Chemicals and Genetically Modified Organisms		
Ozone Depleting Substances	Regulation 3093/94	Not estimated
Animal experiments, GMOs, laboratory practice et al	86/609, 90/219 am. etc	Not estimated
H. Noise from vehicles and machinery		
Motor vehicles, motor cycles, plant, aircraft, appliances	70/157, amen. + others	Not estimated
I. Nuclear Safety and Radiation Protection		
Radiation Protection of General Public & Workers etc	80/836, 97/43, 96/29 etc	Not estimated

2.0 ENLARGEMENT PROCESS – GENERAL CONTEXT

2.1 Environmental Benefits and Wider Economic Development

Although it is important to try to quantify the environmental impacts of the environmental directives, the issue of the impact on wider economic development of environmental investments is also important. Indeed, the investment in the environmental chapter of the acquis should be seen within the context of broader development goals as there is a potential for environmental investment to influence local, regional and national development. Furthermore, the implementation of other parts of the acquis (i.e. non environmental chapters) also have the potential to lead to major positive and negative impacts on the environment; the impact on the environment from the specific environmental chapter acquis needs to be seen in the context of the environmental impacts of the acquis as a whole, including non environmental chapters.

The interactions between the environment and economic activity are two-way. Investment in economic sectors can lead not only to greater economic efficiency of the sector, but can improve environmental performance, for example through new more efficient capital stock. Similarly, improved environmental quality (e.g. application of clean processes, or savings through appropriate pollution and natural resource management mechanisms) can lead to economic savings, support competitiveness and subsequently further investment and productivity. These latter benefits can apply to the enterprise itself or to a larger set of players. Where for example, the surface water quality improves due to reductions in emissions, there is a lesser need for pre-treatment and associated pre-treatment costs. Furthermore, the increased availability of clean natural resources and availability of an efficient environmental infrastructure can improve the locational quality of a locality or region and hence attract investment, whether local, national or foreign.

The final effect clearly depends not only on what the money is spent on, but also on what the money is no longer spent on, and it is the challenge of development planning to ensure that the net effect of the investment choice, as guided by policies, planning and incentives encourage a move toward more sustainable development and sustainable economic growth. It would be too simplistic to argue that environmental expenditure leads to economic and regional development benefits and not take the adverse impacts of decisions into accounts. However, a full assessment is not possible here. Nevertheless it is important to underline the potential for a positive effect on the economy (see also Part F on employment impacts), as this is a real potential benefit from appropriately planned environmental expenditure.

Table A.2 summarises key interactions between major economic sectors and environmental themes.

Table A.2: Indication of the Significance of the Relationship between Economic Sectors and the Key Environmental Themes of the Region

	Priority Industrial Sectors				
Environmental Theme	**Energy**	**Transport**	**Industry**	**Agriculture**	**Tourism**
1. Climate Change	***	***	***	*	◊
2. Air Quality	*	***	***	◊	◊
3. Water	*	*	***	***	*
4. Nature and Biodiversity	*	*	*	***	*
5. Landscape	***	***	*	***	*
6. Soil /Land Quality	*	◊	***	***	◊
7. The Urban Environment	*	***	*	◊	*
8. Noise	*	***	*	◊	◊
9. Waste Management	***	**	***	*	*

Source: adapted from European Environment Agency

Key: *◊ Nil or insignificant; * Some impact ; *** Substantial impact*

It is sometimes assumed that taking steps to maintain or improve environmental quality must always make economic development more costly – or indeed inhibit the opportunities for employment growth. Thus meeting environmental regulations and standards is seen by some as a burden on development programmes.

In fact the relationship between economic growth and the maintenance of environmental quality is by no means so simple. It is of course true that in some individual cases environmental controls may inhibit growth or make it more costly: for example the limitations on construction in locations which are important habitats; or the extra costs for small and medium sized enterprises investing in end-of-pipe pollution control equipment. However, at the level of a regional or national economy there is no evidence that environmental regulation and improvement reduces economic growth or costs jobs. Indeed all the main economic studies suggest that maintaining and improving environmental quality will have a small but positive effect on economic and employment growth. It should also be noted of course that a poor environment would increase the costs of development and reduce the attractiveness of an area to investors and others.

Some of the reasons for this positive effect between environmental improvement and employment are set out in Box A.2. It can be seen that many of these are "efficiency" effects in which reduced use of natural resources or wasteful production can help reduce firms' (or the economic system's) costs and so make them more competitive. It is also increasingly the case that investors, tourists (an important growth sector) and high skilled mobile workers (on whom many new growth sectors rely) are prepared to locate only in regions with a good environment and high quality of life. Thus whilst there sometimes have to be trade-offs between employment and environment for particular projects, for a regional or national economy as a whole a certain level of environmental quality is important for successful development.

Box A.2: Employment and Environment

- A high quality environment attracts jobs; a low quality one is more costly to develop.
- Firms can reduce costs, be more competitive and retain employment by reducing energy and water use and reducing emissions and waste charges through improved management or using cleaner technologies.
- SME's can be helped to adjust to increasingly stringent environmental standards thus retaining jobs.
- Firms can find new markets, get a clear market position or get a competitive edge by providing goods and services that are environmentally responsible.
- Firms can innovate and develop new products and services that use less materials, energy and produce less waste and/or respond to consumer demand for " green" and environmentally responsible products.
- Some industry branches use fewer resources and produce fewer emissions than others and many of these are "employment growth" sectors.
- Regional economies that are spatially dispersed and rely on private road vehicle and road freight are likely to become more costly (and hence less competitive) as controls and charges on vehicle fuels increase.
- Regions that are more compact, embrace mass transit and rail systems and the potentialities of IT are less vulnerable to increasing travel costs.
- Regions that enable development to use existing infrastructure, reduce the pressures on areas of natural assets.
- Regions with a spatial planning structure that enables firms to locate so that they can share heat, exchange waste materials, etc will have a competitive advantage.

It is also important to understand the economy environment relationship in the longer term. On the whole, under the current patterns of development, the greater the economic growth, the greater the increase in production and consumption and the greater the use of environmental resources, amounts of waste, by products and emissions produced. The sustainable development model calls for a reduction in current levels of environmental resource use and a radical change in production and consumption patterns allowing for economic growth without compromising the environment. (This is represented graphically in Figure A1). The key to sustainable development is a focus on generating economic growth, employment and enhancing opportunity for all, whilst:

- Meeting higher environmental standards for power generation, industry, water services and waste management;
- Reducing the environmental impacts of agriculture and transport;
- Beginning to shift the development pattern and economic structure away from those sectors that have a big impact on the environment.

It is important again to not present an over-simplistic picture. While the overarching development path is one where natural resource use and pollution are linked to economic growth, there is in many cases a partial "decoupling" of environmental impacts from economic growth, and even an opportunity for breaking the trend. In many candidate countries the natural resource intensity and pollution intensity of production has fallen since 1989, and there had been a decoupling of some pollutants from economic growth. It remains to be seen whether pollution and natural resource use will in due course be relinked, albeit at a lower intensity.

The lessons from the EU Member States[1] suggest that partial decoupling is possible. Lessons also show where mistakes have been made or where decoupling has not been possible. The candidate countries could benefit from avoiding some of the mistakes that the Member States have made (e.g. growth of private and goods transport by road).

Other elements of the acquis, especially that directed to stimulating economic and regional development and reducing the gap in GDP per capita between the EU and the candidate countries, will have an equally important impact on the environment. Building roads, developing sites and factories will all have a ***direct*** impact on the immediate environment, as will the implementation of a common agricultural policy. However if they are successful as economic development projects they will have a wider and often larger ***indirect*** effect on the environment. Almost all successful projects and measures will increase economic activity, travel and so on which will necessarily mean a greater use of resources (water, energy, materials) and a greater production of waste and emissions. A more sustainable economic development strategy will try and reduce both the ***direct*** and the ***indirect*** environmental effects of the economic growth it stimulates.

Economic Growth and the Environment

The benefits will depend on the decisions taken by the candidate countries as well as the economic development path they choose. There are basically three options:

a) "Traditional Business as Usual". Economic growth leading to increased environmental damage[2] and higher economic, social and health costs.
b) Economic development while reducing the impact on the environment. Applying cleaner technology and minimising waste without any fundamental change to economic decision-making.

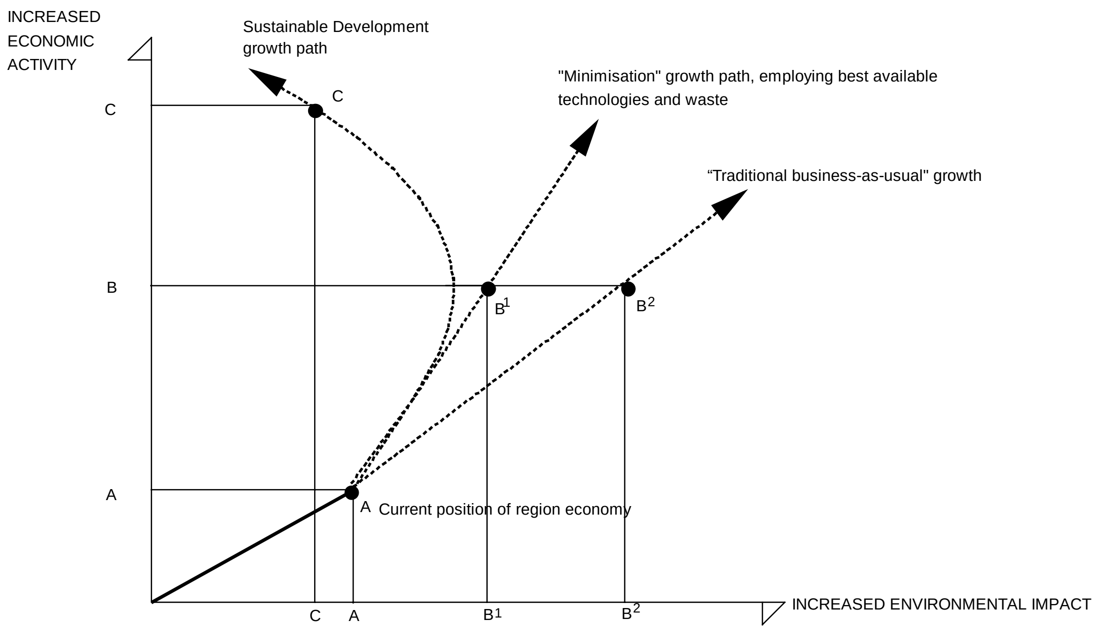
[1] See EEA (2001) *Environmental Signals 2001*. European Environment Agency Regular Indicator Report. Environmental Assessment Report No 8.
[2] This is overall true for many economies, though clearly there are sectors and issues for which environmental impacts are decreasing despite economic growth. Successes include the reduction of acidic emissions from the power sector for example. Examples of failures relate to increased CO2 emissions from transport. In addition, there are certain times when economic restructuring leads to significant environmental benefits through often one off gains (closure of aged polluting plant). Once this process is complete, the same pressures on the environment related to economic growth will resume. It certainly is the case in most of the candidate countries that the pollution intensity has dropped significantly since 1989.

c) Sustainable development. Continued economic growth but with a significantly reduced impact on the environment taking fully into account environmental and social concerns into the decision-making process.

The sustainable development option is less in line with the European Commission's proposal for a 6th Environmental Action Programme (and Sustainable Development Strategy) according to which the aim should be a continued economic and social development with due concern shown to the environment and natural resources. The three paths are noted in Figure A1.

Where there is an understanding of the full range of benefits of implementing the acquis, and where decisions reflect this understanding, implementation will contribute towards adopting the sustainable development path.

FIGURE A1: ALTERNATIVE DEVELOPMENT PATHS



The implication of the current or traditional "business as usual" development model is that as the economy grows from point A that growth will inevitable result in a growing environmental impact. The country or region will end up at point B2. This environmental impact may be ameliorated to some extent by ensuring that the best available environmental technologies and waste minimisation approaches are used. By this means the increase in the environmental impact of the growth can be **minimised**. In other words the region is brought to Point B1. However, following such a "waste minimisation" growth path will still result in an increased environmental impact, albeit less than under the "business as usual" growth path; that is position B1 rather than B2.

The full "sustainable development" position is to move to a new type of development model where increased economic activity becomes "de-coupled" from the environment and **growth can continue with reducing environmental impact** (ie. position C in the figure). This has a **reduced** environmental impact compared to that which is currently obtained (C compared to A) and allows "continued economic and social development without detriment to the environment and natural resources" (5EAP).

The implementation of the acquis can influence the environmental impact as the programme can bring about changes in the way that sectors operate. Key changes that might be attributable are as follows:

- *Agriculture* – programmes will influence structural changes within the sector, such as diversification and innovation in practices, as well as changing overall levels of activity. Impacts measured, for example, in terms of changes in number of farm units by farming activity (e.g. livestock intensity), with implications for assets such as landscape and also resource use (e.g. pesticides or fertiliser);
- *Energy* – programmes will bring changes in resource efficiency of consumers, either through changing nature of supply (e.g. renewables) or reducing demand (e.g. insulation). Programmes will influence overall levels of energy consumption, due to higher levels of economic activity and income levels;
- *Industry* – programmes will affect the resource efficiency of business (e.g.. from waste minimisation programmes). They will also influence overall levels of resource consumption (material inputs and pollution) reflecting higher levels of activity in the economy;
- *Transport* – programmes will influence the resource efficiency of business/consumers (e.g.. improved public transit systems or reducing logistics/freight intensity of business). There will also be impacts from changes in overall levels of transport demand reflecting higher levels of economic activity and income levels;
- *Tourism* – programmes will influence changes in the overall numbers and types of visitors or visitor days (e.g. on landscapes/habitats in rural areas), with subsequent impacts on the environment in destination locations. There will also be impacts associated with the resource efficiency of visitors (e.g. the extent to which additional visitors are able to use public transport).

In summary, there are two development effects to consider:

i) Changes in overall levels of sectoral activity attributable to the acquis; and

ii) Changes in the resource efficiency of the sector, attributable to the acquis, including the contribution of the environmental chapter.

Whilst this study is primarily concerned with the consideration of the environmental benefits (and especially those which lend themselves to monetisation) from the implementation of the environmental directives of the acquis, these results should be understood within this wider development context. The study also presents some results on the social, economic and wider economic benefits to complement the environmental insights and underline the fact that implementing the environmental acquis is not just an issue of concern to the “narrow” environmental field.

2.2 The Compliance Gap

The compliance gap and challenge for the candidate countries are partly reflected by the status of infrastructure that is required to comply with the EU environmental *acquis.* Table A.3 gives an indication of what could be called the 'infrastructure gap' in the candidate countries. The infrastructure gap refers partly to existing non-compliant infrastructure (i.e. non-sanitary landfills) that will have to be brought into compliance with EU norms and standards. It also refers to 'missing infrastructure', which is infrastructure that does not exist or that exist only partially in the candidate countries at present (i.e. drinking water supply systems) and that needs to be set in place as required by the EU environmental Directives.

The scale of the infrastructure gap and challenge of implementing the acquis is indicated by the table. For example in the waste management sector, in most of the candidate countries, many of the existing landfills are non-compliant with the waste management *acquis*; most will have to be upgraded or closed down and replaced by new and compliant structures. In other words a significant share of the 1,186 landfills in Poland, the 1,133 landfills in Romania, and 2,500 landfills in Bulgaria, will require upgrading or closure for the full implementation of the acquis.

The extent of the infrastructure gap varies between countries for the same type of infrastructure and between infrastructure sectors for the same country. For example, Poland will be required to bring in compliance 200 LCPs and around 4,000 IPPC installations while Slovenia will have to upgrade 8 LCPs and 108 IPPC installations. Though 'better-off' than Poland in terms of the number of LCPs and IPPCs that will have to bring in compliance with the EU standards and norms, the challenge for Slovenia is still significant. Similarly, there are over 70 non-compliant incinerators in the Czech Republic, while Latvia and Cyprus have no incinerators at all. Depending on the size and location of the incinerators and the type of waste incinerated, the Czech Republic may have to allocate significant financial resources to ensure compliance with the waste management Directives by the date of accession.

Regarding the 'missing infrastructure', the gaps lay mostly in the water management sector. Sewage collection and drinking water connection rates vary significantly between the candidate countries. 100% of the sewage is collected in Malta and 77% in Estonia but less than 50% in Cyprus and around 54% in Romania. Connection rates also vary largely between rural and urban areas: in Poland, 78% of the population is connected to wastewater treatment in urban areas but only 9.9% in rural areas.

The ability of the candidate countries to cover the infrastructure gap will depend mainly on their financial capacity. However, the capacity to upgrade and/or build new infrastructure will also be dependent on the capacity of the construction and eco-industry sectors to provide the goods and services required for setting up, in certain cases significant, compliant infrastructure in a relatively short period of time.

Any further analysis related to the infrastructure gap and based on the infrastructure data presented in Table A3 should be made with great caution, as there are several factors that may alter the quality of the data. Firstly, data has been collected from various sources i.e. ISPA

Strategies, World Bank reports and the assumptions behind the data presented where not always clearly defined. This may have lead to double counting where for example it was not made clear if the IPPC installations include or not large combustion plants.

Secondly, previous research showed that various infrastructure having to comply with the environmental *acquis* might be defined differently across the candidate countries. For example, there are candidate countries, which have chosen a different cut-off year for new and old IPPC installations than the year specified by the Directive. Looking at the drinking water connection rates, some candidate countries refer to the percentage of agglomerations with water supply, while others refer to the percentage of households attached to water supply systems; this creates higher drinking water connection values for the former.

Where information was available, data was provided on the compliance status of existing infrastructure (i.e. number of compliant landfills). However such information is missing in many candidate countries. Difficulty in obtaining infrastructure information has been evident in several candidate countries i.e. Turkey, Cyprus and Malta. Other candidate countries have still to identify installations that will have to comply with the environmental *acquis* (i.e. Seveso installations in Romania).

Despite the caveats on how to interpret the data, the table provides a valuable overview of the compliance gap. The scale suggests that there could be significant benefits and that an estimation of the scale of the benefits could be a valuable exercise. A summary of the estimates of the actual benefits is presented in Chapter 4, and more detail is given in Parts B to F.

Table A.3 Current Status of Environmentally Related Infrastructure in the Candidate Countries

INFRA-STRUCTURE TYPE	COUNTRY												
	BULGARIA	**CYPRUS**	**CZECH REPUBLIC**	**ESTONIA**	**HUNGARY**	**LATVIA**	**LITHUANIA**	**MALTA**	**POLAND**	**ROMANIA**	**SLOVAKIA**	**SLOVENIA**	**TURKEY**
Air													
Large Combustion Plants (LCPs)	36 2 extended after 1997	3	~ 125	24 (existing) & 3 (planned)	95	27	48	2	200	69	88	8	~ 15
Waste													
Landfills: total	2,500 (most non-compliant)	5	340	263	1,042 (most small)	550 (all non-compliant)	850: only 300 (non-compliant) operate	2	1,861	1,133: 287 urban & 846 ind. (non-compliant)	141	87	2,111
Landfills: sanitary	:	0	288	2	728	0	:	:		:	106	60	7 (& 2 composting plants)
Incinerators: total	8 (non-compliant)	5 (small, clinical waste)	75-8	2 (incinerators) & 1 (co-incinerator)	1 municipal & 52 hazwaste	0	0	6 (small)	23 + 5 co-incinerators	3 (for hazardous waste); there are no urban incinerators	67	5	
Incinerators: compliant	:	0	6	0	1 municipal 41 hazardous	0	0	0		:	17	5	1
Water													
Sewage connection rates (% of population connected to sewage systems)	72%	45%	74.6%	77%	61.00%	76.9%	59%	100%	82.8% (towns) 9.9% (rural)	51%	54.3%	53%	62%
Wastewater treatment plants (WWTPs): total number	61	4	959 (Urban WWTPs)	826	496	346	785	1	1,675 (industry) & 2209 (municipal)	1,000	334	132	16 completed & 16 under construction
Wastewater treatment (% of population connected to WWTPs)	63%	45%	68.6%	77%	34%	64%	52%	8%	78% (towns) 8.5% (rural)	30%	50.8%	35%	12%
Drinking water connection rates (% of population connected to drinking water supply)*	99%	99%	86.9%	77%	93%	83%	75%	99%	91.5% (towns)	~54%	82.6%	85%	78% (urban) 62% (rural)
Industrial Pollution													
IPPC installations	380 – 400	20-25	1,000-1,500	141	1,000	110-130	:	60	4,000	729	646	108	:
Seveso installations	150	12	110	21 (10 (A) + 11 (B))	319	40-50	150	7	150 (Seveso II)	Not identified	123 (45 upper tier)	50 (30 upper tier)	:

*Sources: World Bank (1999,2000), ISPA Strategies, EUROSTAT (2000), JEMU (1999 & 2000). *Note: some of these apply to population, others to % of agglomerations.*

2.3 Investment Costs for Complying with the EU Directives

It is clear that the cost of implementing the directives is beyond the short or even medium term capacities of many countries and sectors of the economy. Table A.4 gives an overview of the costs of implementing the acquis as noted in the Communication from the Commission - *The Challenge of Environmental Financing in the Candidate Countries (CEC 2001).* The estimates of total compliance costs vary from 121,500 MEUR (EDC, 1997) to 79,260 MEUR.

Table A 4: Estimated Environmental Financing Needs in Candidate Countries

Country	**BG**	**CY**	**CZ**	**EE**	**H**	**LV**	**LT**	**MT**	**PL**	**RO**	**SK**	**SI**	**Total**
Total Cost 1997 Estimate MEUR	15000	1118-1264	13400	1500	13700	1710	2380	NA	35200	22000	5400	1840	122618-122764
Recent Figures Total Cost MEUR	8610	1086	6600-9400	4406	4118-10000	1480-2360	1600	130	22100-42800	22000	4809	2430	79260-110001

Source: CEC (2001) Communication from the Commission - The Challenge of Environmental Financing in the Candidate Countries

These values are presented here to help provide a context for the analysis and the scale of the challenge. It should be underlined that this study has explicitly refrained from comparing the benefits results to the above cost estimates during the study analysis, and only carried out an overall comparison when writing the conclusions of the study. The study team believe that the only valuable comparison one can make between the benefits estimates and cost estimates is one where the total benefits are seen in context of the total costs, such that the importance of the benefits (see later chapters) is highlighted, but always seen in context of the meaning of the benefits assessment and cost estimates. The study team warn against any simplistic comparison; this issue is discussed in more detail in Chapter 5.

2.4 Implementation Time-scale

The scale of the challenge is compounded by the speed at which compliance is expected to take place. For most candidate countries it is intended that the approximation process should be largely completed over the next five years. Where there are clear difficulties for particular directives, some candidate countries are negotiating a longer period of time for implementation (called transition bids), but in most cases not longer than 2010. In some cases international agreements to which certain candidate countries are signatories, notably the Gothenburg Protocol, which sets emission ceilings for four major pollutants, SO2, NOx, NH3, and NMVOC, and which are closely related to the emission reductions aimed for under

EU directives, also need to be implemented quickly. In the case of the Gothenburg Protocol emissions reductions of 50% are not uncommonly required, by 2010.

The issue of timescale is important in the context of this study because the timing affects when the benefits of compliance begin to appear. This in turn influences the value of benefits that are estimated. The earlier the implementation, the earlier the benefits begin to appear, and therefore the greater the total benefits. This is also affected by the effect of discounting – as future benefits are smaller in today's term (present values). Hence a high discount rate will reduce future benefits, and therefore a delay will not only put benefits off, but also make them worth less in today's terms. Conversely, early implementation will increase the value of the benefits. This issue is considered explicitly in the analysis of the monetary benefits.

On the other hand, delaying investments will not reduce the actual investment costs, though will make these costs smaller in net present value terms. Furthermore, delaying new investments (rather than replacement investments) will delay the payment of operating and maintenance costs, effectively reducing expenditure levels through reduced environmental service. Where the investment is a replacement investment (with other infrastructure closed) or upgrading of existing infrastructure, then the effect on operating and maintenance costs is likely to be small and depends simply on the relative O&M costs of the upgrade/replacement with respect to previous O&M costs.

Early implementation does increase both benefits and costs, but increases benefits by more than it does increase costs, and late implementation reduces benefits by more than it reduces costs. Furthermore, a high discount rate has a larger effect on benefits than on costs[3] - reducing total benefits by more than costs.

As discussed in more detail in Chapter 3, the study core assumption is a full implementation by 2010, and sensitivities have been carried out for an early and a delayed implementation. Given the status of the challenge, and the level of commitment, the study team consider the 2010 full implementation date as a good representation of the overall implementation (See Chapter 3).

[3] The discount rate reduces benefits by more than it does costs, given that the whole of the benefits is subject to the discounting, while only the O&M and part of the capital costs (those spend later on) are affected by the discount rate. Benefits continue to accrue for long periods after the capital costs have been paid, and, even taking the O&M costs into account (which continue for the life of the infrastructure), the long term is relatively speaking more important for benefits than for costs.

3.0 METHOD OF APPROACH

3.1 Overview

The purpose of the work has been to highlight and assess the benefits to the candidate countries from implementing the environmental acquis communautaire – covering the 13 candidate countries, a wide range of directives and pollutants. To obtain the insights into the benefits, three levels of analysis have been carried out – an assessment of the type and nature of the benefits accruing to the candidate countries, the extent of the benefits and the (monetary) value of these benefits. Each level offers a particular means of highlighting the benefits. While the analysis leads to the monetary assessment, it is important to underline that the qualitative analysis is an equally important analysis, and indeed in many ways more important given its greater coverage of directives.

While all of the work in the study is new work, it is not the first study that has sought to assess the benefits of compliance in the candidate countries (though there are only few). The current study work has therefore tried to build on the lessons of past work, and both broaden and deepen the currently available analysis of the benefits from implementation of the EU environmental acquis in the candidate countries.

The following activities have been undertaken, in order to broaden the analysis:

- A wider set of directives have been considered and characterised than previous studies. This includes a more accurate representation of the impacts of the air directives and the inclusion of waste management and nature protection related directives (the previous analysis has considered only the principal water related directives and sought to approximate to air quality directives);
- A wider set of pollutants have been covered;
- A broader range of benefits has been covered than in previous analysis. In this study social and economic benefits have been considered as well as the environmental benefits. The politically important consideration of employment has been included;
- Three countries (Cyprus, Malta, Turkey) have been added to the ten countries previously examined.

In order to deepen the analysis:

- A qualitative appraisal of the major benefits across the whole environmental chapter, and in some cases a quantitative but non-monetary analysis, has been added to the monetary analysis of environmental benefits; and
- The monetary analysis of environmental benefits has been broadened to cover a wider range of directives and deepened by taking better account for methodological issues such as the links between implementation measures/targets and physical effects, the timescales and hence timing of benefits, and the calculation of net present values.

The quantitative and monetary analysis has combined: An update analysis of existing work and the earlier benefits study; with new analysis - new directives, new benefits and three additional countries.

The team has sought to find and use new data in order to complement and build on existing data, by using national experts to obtain available data. However, there remain important data gaps that prevent, in certain areas, especially in relation to the impact of the water related directives, a more rigorous analysis. The team has not developed new dose-response functions, given the resource-intensive nature of this exercise.

3.2 Appraisal Framework

The basic appraisal framework combines a qualitative assessment of the benefits from a wide range of directives for all candidate countries, with an assessment of the extent of the benefits for a subset of impacts, and an assessment of monetary value of the benefits from implementing the directives (or bundles of directives, where specific attribution of effects to individual directives is problematic).

The appraisal of benefits, and use of the appraisal, should recognise that it is only possible to develop monetary values of environmental benefits for a limited number of benefits. Other benefits can be considered, but not in monetary terms; and some effects can be noted but remain unspecified due to lack of information.

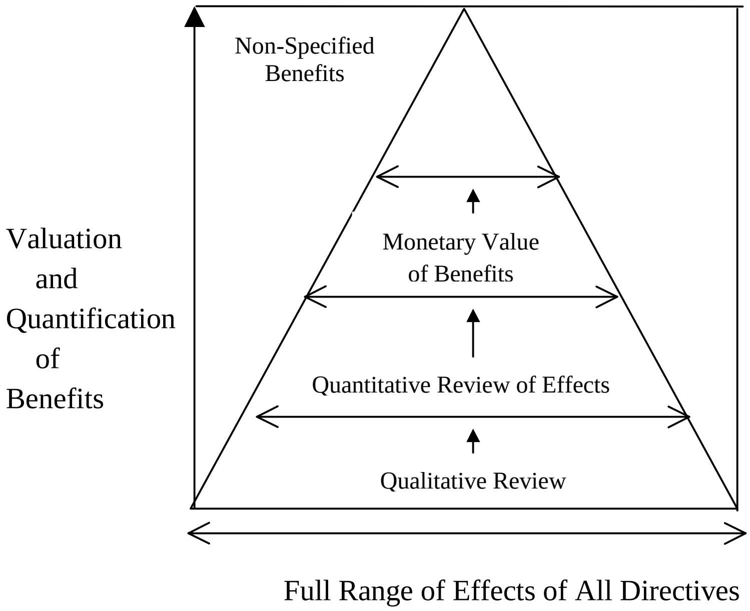
This situation can be presented as a 'pyramid' of benefits, with monetary estimates at the top, followed by the quantitative analysis, a broad qualitative review, and the full range of benefits in principle available from the implementation of the environmental acquis communautaire noted at the base (Figure A.2).

This therefore provides three levels of analysis – the qualitative, the quantitative and the monetary step. Even the qualitative step does not present all benefits from all directives as covering all directives was beyond the scope of the present study (see below on selection of directives).

Given the difficulty of attributing monetary values to benefits (and in some cases this is impossible), the economic estimates necessarily cover fewer benefits than the other two steps in the analysis. It is therefore especially important to look at each level of the analysis as offering valuable insights in itself and not only regard the qualitative as a step towards the quantitative which in turn is a step towards the monetary evaluation. Focusing only on the monetary analysis would be losing part of the richness of the analysis and indeed the value of benefits analysis.

In addition, there is a third axis, indicating the level of confidence in the results given the status of scientific knowledge underpinning the work (some dose-response functions are more researched than others).

Figure A.2: Benefits Pyramid



Selection of directives

Table A1 in Section 1.3 noted the directives that are the focus of the analysis within the study, and the level of analysis. It is important to note that the selection does not suggest that there are no or only marginal benefits from the proper implementation of directives not noted: For example it is clear that the following directives will have important benefits:

- EIA (85/337, amen. 97/11/EC) – the proper implementation of this directive will help reduce environmental impacts, taking local environmental sensitivities into account properly, and offer benefits to civil society of through information provision and participation.
- Ozone Depleting Substances (3093/94) – avoid contributions to the problem of the ozone hole, helping reduce the risk of skin cancer and cataracts globally;
- Public health: protection of individuals against ionising radiation in medical exposures (97/43/EURATOM) – reduced risk of exposure from radiation to both workers and general public
- The risk based directive on GMOs (2001/18/EC) – will reduce the risks associated with the release of GMOs
- Occupational safety and health: risks related to chemical agents (98/24/EC) – this would reduce occupational exposure for workers and hence protect health.

This issue of chemicals is particular important, but also particularly difficult to assess the benefits and considered outside the scope of the study. Again this does not imply that this was not considered important and an appreciation of the benefits will be important for related policies[4]. Similarly, the fact that for some directives only a qualitative analysis has been carried out does not suggest that there are no substantive benefits worth quantifying, but rather that the data or scientific methods are not available to allow for such an assessment.

3.3 The Basic Method

As noted above, in order to deepen the analysis, the basic method comprises three main stages:

- A qualitative review of the potential effect (directive-by-directive), noting any major changes within candidate countries;
- A quantitative appraisal of the effect in terms of changes (reduction) in pollution and/or damage, for selected directives (often grouped together), again noting the effect by individual candidate countries;
- The monetisation of changes in pollution and damage, where data and scientific methods allow.

In practice, the main limiting factor on the extent of monetisation is the availability of quantitative data relating compliance with changes in emissions and/or receptors.

3.3.1 Assessment of benefit

The benefit of implementing any directive in the candidate country depends upon how far current practice deviates from the standards and practice explicit in the directive. Highly polluted environments or products will, of course, demonstrate the most benefit as they are brought in line with strict environmental standards. In other words the benefits of implementing the acquis are measured by looking at the avoided damage as the directive is implemented.

Given that the state of environmental standards, compliance with these standards, and scale of activities, which should meet the standards varies across the candidate countries, the benefits of approximation for many directives will be highly uneven spatially. Countries of Central and Eastern Europe have a combination of highly contaminated environments and relatively pristine environments. For the former the benefits of approximation may be clear. For the latter approximation is important, although in this case it is by giving protection from future exploitation. Naturally, this can only be described in the most general terms.

A particular problem also arises where a directive requires that certain areas (e.g. sensitive areas, shellfish waters) are required to be designated prior to action being taken. In many Member States such designation has been used to limit action and the Commission is involved in a range of legal actions in this regard. The benefits of bathing waters, shellfish

[4] See the White Paper: Strategy for a Future Chemicals Strategy, COM(2001)88.

waters, nitrates and many other directives will depend upon how extensive designations are and to what extent they relate to truly environmentally sensitive issues[5]. Currently, designation for EU directives in only beginning to take place in the candidate countries. As a result the benefits can only be assessed by assuming relatively widespread designation.

3.3.2 Assessing benefits: understanding the logical pathway of pollutants

In order to assess the benefits of compliance with environmental legislation it is necessary to understand how the pollutants (or other issues regulated) relate to the receptors under consideration. Various models exist to determine such impacts and the quantitative assessments later in this report draw upon these. For the qualitative assessment it is sufficient to consider generalised models of understanding such as the DSPIR Framework - **D**riving force (causes) - **P**ressure (pollutant) - **S**tate (quality) - **I**mpact (health, ecosystem, materials) - **R**esponse (policies and targets) -, although the subject of 'response' is not appropriate for discussion here (the response being compliance with the acquis) apart from in a few special cases (different responses can lead to the compliance but with wide ranging impacts: notably for the Landfill Directives, see Part D). When looking at the step of quantification and monetisation of benefits, we also use dose-response functions. Here the dose is the level of pollution and the response is the impact on health and materials[6]

It is important to distinguish different types of interaction with receptors to understand the nature of the benefits and to see the benefits in context. In particular, pollutants may be damaging at extremely low concentrations. In this case it may be determined that there is no 'safe threshold' for their presence in the environment. Completely eliminating them from the environment may, however, be impractical and, therefore, environmental standards are set to minimise impacts, but in a way that is practical, both technically and economically. Some pollutants are, in contrast, found to have thresholds for impact and, therefore, standards are usually determined in such a way as to achieve concentrations below which no impact is expected. The acquis communautaire addresses both pollutants with and without damage thresholds.

A wide range of substances is considered to have no threshold for impact, at least in particular circumstances. These include:

- Certain air pollutant effects on health: e.g. small particulates and nitrogen oxides.
- Carcinogenic substances, e.g. benzene in air or PCBs in any medium.
- Endocrine disrupters (strictly speaking a threshold may exist, but at exceptionally low concentrations).

The important issue for benefits assessment is that while environmental standards may be established for such substances, a benefit will continue to accrue even if further reductions are achieved below this standard. This is often not appreciated by many stakeholders who

[5] It is unlikely that a derogation would be given for an area where significant damage would ensue from the derogation.
[6] In other words the "response" of the dose response function is the "impact" in the DSPIR framework.

consider that meeting the standard means that the problem has 'gone away' and as a corollary that there is no benefit in going beyond compliance. For pollutants without threshold damage values, there are benefits to going beyond compliance. In other words, there remain benefits of going beyond compliance with the acquis[7].

There are a number of substances where threshold effects occur. These are often naturally occurring substances, where the pollution represents an unacceptable (when above the threshold) increase in the concentration of a substance in the environment. These include:

- Acidifying substances on soils and water where they exceed natural acid neutralising capacity; and
- Air pollutants with threshold effects on vegetation; e.g. sulphur dioxide and nitrogen oxides.

In these cases, where the standards are incorporated into the acquis, compliance with the legislation may in most cases be assumed to provide full protection[8] and, therefore, maximum benefit. In other words there are no benefits of going beyond compliance for these pollutants.

3.3.3 Benefits and the acquis

The acquis can be considered as protecting the environment by a number of different mechanisms. However, in terms of a general assessment of pollution benefits, two main strands are discernible:

- Compliance with environmental standards, i.e. meeting objectives in the environment itself (e.g. air or water quality standards).
- Emission standards/reductions, i.e. discharge limits, product standards, and BAT, to eliminate or reduce emissions of specified pollutants.

These two approaches are closely linked together, and the former are sometimes called "upstream" directives and the latter "downstream" directives.

For example, the first daughter directive of the Air Framework Directive establishes an air quality standard for nitrogen dioxide to protect human health. However, the IPPC Directive and the vehicle emission directives regulate emissions of nitrogen oxides from industry and motor vehicles respectively. Finally, the national emission ceilings directive will set overall national limits for emissions of this pollutant.

Benefits can, therefore, be ascribed to all of these directives. Each contributes to the protection of health, although the benefit can only be accounted once. Obviously, in different candidate countries the relative importance of each emission-focused directive will vary.

[7] The study does not make at attempt to assessing the marginal benefits as the directives are implemented or the remaining marginal benefits for possible over-compliance with the acquis.
[8] Clearly there will be cases where the standards in the acquis are above the threshold values given the practical requirements of getting agreement on legislation.

Indeed other measures, such as city planning and traffic control may provide benefits (aimed at meeting the air quality limit value) of equal benefit to the emission limits in the acquis.

It is also important to note that many directives produce multiple benefits. IPPC is a good case in point, which requires the regulator to assess the environmental implications of the discharges from an installation in the process of determining BAT. These could be many and various and are very difficult to determine up front.

Thus in many cases there may be:

- Many directives aiming at delivering the same benefit; and
- Multiple benefits derived from one directive.

For this reason an assessment of benefits is not straightforward in terms of its relationship to the acquis. However, it must be borne in mind that full benefits will only be fully understood by consideration of the inter-related effects of the different directives. As a result these inter-relationships are highlighted in the text.

3.4 Qualitative Assessment of Benefits

This study is focused on providing an assessment of the benefits of approximation to EU environmental legislation. While an assessment of the value of the benefits might be the question foremost in people's mind, it is also important to provide a qualitative assessment, which provides a clear description of the benefits of individual items of EU environmental legislation, and examples of where these will provide clear benefits in candidate countries. These statements do not rely on the particular methodologies used in the quantitative assessment and, therefore, may communicate the benefits of early compliance even if the latter is challenged.

The qualitative assessment of the benefits of implementing the acquis, based on the individual directives highlighted earlier in this report, is important and constitutes a key output of the study. The directive-by-directive analysis is important far beyond its role as a step towards quantification and subsequently to monetisation of benefits. It helps clarify the full range of benefits of implementing a wide set of key directives of the environmental acquis communautaire.

Before classifying the range of benefits that should stem from implementing the acquis, it is worthwhile to note examples of the range of benefits. Examples include:

- Better public health as exposure to pollution is reduced and, as a result, the number of respiratory diseases and premature deaths decreases.
- Less damage to forests, buildings, fields and fisheries through a reduction of acid rain and other forms of pollution – leading to wider economic benefits (increased yields) and reduced costs (building façade works).
- Lower risk of (irreversible) damage to natural resources such as groundwater aquifers.

- Better protection of natural ecosystems and (endangered) species.
- Promotion of tourism as a result of a cleaner environment (forests, rivers, nature reserves).
- Reduced risk of water-related illnesses and improved taste of water as a result of better bathing water and drinking water quality.
- Increased economic efficiency and higher productivity as a result of modern technology, supporting competitiveness of industry.
- Lower production and maintenance costs through availability of cleaner water, reducing pre-treatment needs.
- Lower consumption of primary material as a result of a more efficient use and higher levels of reuse and recycling.
- Support for employment and benefits for local and regional development.
- Company culture benefits through improved awareness of environmental risks and approaches to minimise risks and respond to eventual events.
- Social benefits through greater learning, awareness, involvement and responsibility with regard to environmental matters (e.g. social responsibility and involvement in separation of waste and recycling).

The range and relative importance of the benefits will clearly vary across candidate countries, depending on the state of their environment, economic structures and pollution activities, consumption patterns, and existing standards and related compliance levels.

3.4.1 Types of benefit

The structure of the qualitative assessment is based on the environmental acquis itself. Thus it examines each directive separately. After providing a brief statement concerning the purpose of the directive, it then outlines the benefits in the following classes:

- Health benefits: direct benefits to public health, e.g. reduction of illnesses and avoidance of early mortality.
- Resource benefits: benefits to parts of the environment used commercially, e.g. forestry, agriculture and fisheries.
- Ecosystem benefits: benefits to the natural environment with no commercial interest.
- Social benefits: benefits to society at large, including safeguarding and access to natural and cultural heritage (avoided pollution damage to historic buildings), recreational opportunities (e.g. angling and bathing), social cohesion due to support for employment, societal learning and the development of civil society (due to increased information provision, consultation and involvement).
- Wider economic benefits: knock-on benefits beyond immediate economic exploitation, including local and regional development (attracting investment) often supported by increased employment through environmental investments, eco-efficiency gains, development of new and existing industries/sectors of the economy, balance of payment

and trade effects (reduced imports of primary materials as more waste is reused and recycled), and economic benefits from natural resources (e.g. tourism benefits of beaches recognised to be clean, and eco-tourism).

In each case examples of where such benefits will accrue in candidate countries are given. Some may be highly specific where studies have already been undertaken, while others are more generalised and the exact nature of the benefit would only become apparent as approximation proceeds.

3.5 Assessing the Extent of the Benefits (Quantitative assessment)

Depending on the availability of data, the key benefits identified in qualitative terms in the previous stage have been assessed in more detail, noting, where possible, the extent of the benefits. This review has sought to quantify both environmental and non-environmental benefits resulting from the implementation of selected bundles of directives.

The analysis is intended, as far as possible, to calculate the benefits of each of the directives as implemented through the acquis. However, depending on the available data, it has not been possible to relate estimated environmental changes to specific directives, where more than one directive is responsible for the benefits. For example, changes in emission to air of pollutants such as SO_2, NO_x and particulates result from a number of air related directives. Similarly, implementation of a number of water related directives will result in changes to common ‘receptors’, such as amenity and health effects. To facilitate the analysis, it has been necessary to bundle some of the directives together because of the difficulties of attributing specific environmental changes to the individual directives. A guide to the bundling, based on the pollutants covered by the individual directives, is presented in Table A.5.

The main bundles comprise:

a) Air quality directives (relating to air quality, industrial pollution and mobile sources),

b) Water quality directives (relating to bathing and drinking waters, and covering ground and surface waters),

c) Waste management directives (relating to landfill, incineration and including packaging waste) and

d) Habitat/nature protection directives.

The assessment has sought to identify, where possible, the physical environmental changes attributable to the reduction in pollution and promotion of environmental protection arising from the directives. The first step has been to use judgements based on available information, and advice from national experts, to approximate these changes, on the basis of the nature and timing of implementation, discussed in previous stages. This includes an assessment of the nature and scale of the receptors (number of households, length of rivers, area of building surfaces) affected.

The second step has been to identify changes in specified receptors, which follow from the environmental changes, resulting from changes in pollution and environmental protection. Key receptors include people (health and safety), buildings, agricultural, fisheries and forestry production, and species diversity. Where possible, 'dose-response' relationships linking changes in receptors to environmental changes have been used.

The review has focussed mainly on the environmental benefits, but included attempts to quantify non-environmental benefits, in particular, the number of jobs generated from the capital and revenue expenditure, and the benefits to industry of new investment in lower emissions technologies and products (see Table A4). The employment impacts constitute an important aspect of the benefits valuation, though the results need to be seen in the context of data availability and methodological assumptions.

Table A4: Benefits Quantified across Media

Benefit Type	Air	Water	Waste	Nature
Health	Respiratory diseases	Number of households benefiting from improved water quality	Not quantified	Not quantified
Resource	Building stock; Crops	Reduction of contaminants in surface water	Reduced primary inputs	Not quantified
Eco-systems	Global climate	Likely changes in river water quality	Avoided methane emissions	Protected areas, species
Social	Not quantified	Not quantified	Not quantified	Not quantified
Wider	Employment	Employment	Employment	Not quantified

Note: The sources for information combine statistical yearbooks from the candidate countries, ministry and institute publications, European Commission funded studies (e.g. Phare and DISAE) and input from the candidate country experts.

Table A.5: Indicative Guide to the Bundling of Pollutants by Directive

	Air												Water									Soil		Waste			Bio-Diversity
	SO2	NOx	Particulates	VOCs	CO2	CO	Heavy metals	Dioxins	Furans	Halogens	Ozone	CH4	BOD	COD	pH	Nitrogen	Phosphorus	Heavy metals	Dioxins	Fluoride	E. coli	Heavy metals	pH	Domestic	Industrial	Inert	
Air Quality																											
Large Combustion Plants	X	X	X																								
IPPC Directive	X	X	X		X	X	X			X															X	X	
Emissions from Mobile Sources	X	X	X		X	X	X				X																
SO2 and Particulates (to be replaced by DD)	X		X																								
Nitrogen Oxides (to be replaced by the DD)		X																									
Lead (82/884/EEC) (air quality standards) (to be replaced by the DD)							X																				
VOC Emissions from Storage and Transport of Petrol				X																							
VOC-Solvents Directive				X																							
Tropospheric Ozone Pollution (to be replaced by the DD)											X																
Waste Incineration Directive	X		X			X	X	X	X	X																	
Hazardous Waste Incineration Directive	X	X	X		X		X	X	X	X																	
Waste																											
Landfill Directive												X			X			X		X				X	X	X	
Hazardous Waste Directive																									X		

Titanium Dioxide													X	X	X	X		X							X		X
Packaging and Packaging Waste																								X	X	X	
Waste Oils																									X		
Disposal of PCBs and PCTs																									X		
Batteries and accumulators containing dangerous substances																								X	X		
Sewage Sludge used in Agriculture													X		X	X	X	X				X	X		X		
Water																											
Urban Waste Water Directive													X	X		X	X										
Drinking Water Directive													X	X	X	X	X	X	X								
Nitrates from Agricultural Sources Directive																X											X
Dangerous Substances Discharges																											
Groundwater Directive													X	X	X	X	X	X	X								
Bathing Water Directive													X	X	X						X						
Nature Protection																											
Habitats Directive																											X
Wild Birds Directive																											X
Protection of Forests against Atmospheric Pollution																											X
Trade in Endangered Species																											X
Leghold Traps																											X

3.6 Assessing the Monetary Benefits

As stated above, knowing in qualitative terms the benefits arising from the implementing of the acquis does not directly lead to an ability to quantify the benefits. Furthermore, even in the cases where one is able to assess the extent of the benefits, not all benefits are amenable to having monetary values attributed to them. Again, part of this is due to lack of data, part is due to methodological limitations and limitations of scientific knowledge, and part due to the difficulty of attributing a benefit to a particular cause, as often there are multiple causes for a benefit. The table below summarises the benefits for which it has been possible to attribute monetary values.

Table A6: Benefits Monetised across Media

Type of Benefit	Air	Water	Waste
Health Benefits	Avoided early mortality and respiratory illness	Willingness to pay for clean drinking water’	Through external costs of emissions
Resource Benefits	Avoided damage to buildings and crops	Willingness to pay for clean bathing water	Reduced primary materials use
Eco-systems	Avoided global warming	Willingness to pay for improvements in river quality	Avoided global warming
Social Benefits	Not monetised	Not monetised	Not monetised
Wider Development	Not monetised	Not monetised	Not monetised

Note: Nature benefits were not monetised. For the Waste section, the overall benefits for compliance with the Landfill and Packaging Directives have been estimated, but not broken down by type of benefits.

3.6.1 Valuation of Benefits: Method of Approach

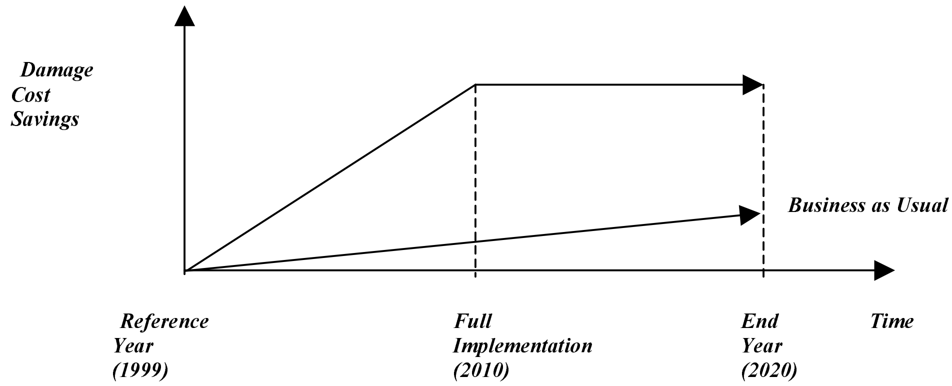
The basic valuation framework (Figure A.6) seeks to capture the savings in damage costs to different ‘receptors’ (people, buildings, eco-systems, etc.) due to reductions in pollution and improvements in environmental management resulting from the acquis.

The valuation of damage cost savings begins at a reference year (taken to be 1999, with the first year of benefits occurring in 2000), and reflects the increasing savings as implementation proceeds, until fully implemented (around 2010 for the core assumption for water and air, 2020 for waste), and the continuing savings in the period thereafter, commensurate with the life of the new infrastructure and over a sensible period for calculation (assumption of 2020 - the present value of benefits after this date becomes small due to the effect of discounting). A sensitivity analysis on the full implementation date was carried out to quantify the impact on the result[9]. There was, however, no sensitivity analysis carried out on the 2020 analysis cut off date as the impact of assuming a longer time period is clear. With a longer time period the

[9] The broad trend is obvious – earlier implementation means that damages are avoided for longer and therefore the total benefits over the period are greater.

benefits would accrue for longer and therefore the benefits over the time period become larger, notably in the cases where low discount rates are used. However, when using the agreed core discount rate (4%) or higher discount rates (in sensitivity analysis), the value, in today's terms, of benefits beyond 2020 become increasingly small[10], and therefore extending the benefits period beyond 2020 would have an insignificant effect on the benefits. In other words, where low discount rates are used, the potential influence on the results is clear, and where higher discount rates are used there is no significant effect, hence no sensitivity analysis has been carried out on the overall benefits time period.

Figure A.6: Basic Valuation Framework



The savings are calculated as the net savings, using the level of pollution and damage in the reference year as the baseline for analysis (i.e. no business as usual savings), where no robust data on alternative developments was available. Since in some cases this represents an over simplification, where there is available data on prevailing trends (pre Acquis) in pollution and damage, which can be used to suggest an alternative 'business-as-usual' baseline, attempts will be made to predict a more realistic change from 'business-as-usual' net damage cost savings. Within the analysis, the business as usual baseline was different from the reference year for the analysis on waste and on air. Evidence on growth in waste arisings and on energy use, suggest that the challenge of addressing waste directives and emissions related to energy use would grow over the implementation period (See Part B on Air, Part D on Waste).

The benefits are therefore calculated against a baseline of projected non-Acquis changes or (in the absence of data) a baseline based on the levels of pollution and damage in the reference year. Damage cost savings are calculated both as an annual value (with results given for the year of full implementation) and as the discounted sum of the annual damage cost savings over the 21-year study analysis period. The annual damage cost savings during the period to full implementation are calculated by apportioning the estimated maximum benefits from full compliance to each of the previous intermediate years. This apportionment has been made on a linear basis, i.e. damage cost savings are assumed to increase directly in proportion to elapsed time. Examining the effect of non-linear exponentially increasing and

[10] The impact on costs is similar; costs beyond 2020 are very small in "today's terms".

decreasing functions has tested the sensitivity of results to this assumption. This can help address the fact that benefits may not accrue in proportion to the elapsed time period available for implementation. In other cases relatively small steps in implementation can yield significant benefits (the 80:20 rule), and marginal benefits can reduce over time.

The benefits are calculated as the net present value (NPV) of the benefits accruing over the period, using a core discount rate of 4% (real) and a number of selected discount rates for sensitivities (0%, 2%, 6%) to allow the sensitivity of estimated benefits to the discount rate to be tested. The general nature of the impact is clear – a discount rate lower than 4% would mean that the benefits under the sensitivity would be higher and with a higher discount rate the benefits over the full study period would be lower.

To simplify: any benefit in year 2020 is worth the same in today's money terms if one uses a real discount rate of 0%. It will, however, be worth little (less than 10% of 2020 value) in today's terms with a 4% discount rate and very little (around 1% of 2020 value) with a 6% real discount rate.

The expression of the benefits of implementing the EU environmental acquis, in monetary terms, has particular importance for the full understanding of the implications of EU accession for the candidate countries in the field of environment.

This monetisation is based on three approaches:

I. The application of unit pollution damage costs to estimated reductions in given pollutants *(unit damage per unit pollutant multiplied by avoided units of emission leads to avoided damage, in other words, benefits)* – this is the approach applied to the estimation of benefits from waste directives;

II. The application of unit receptor damage costs, to estimated reduction in damage to given receptors or receptor valuation of "damage" *(e.g. damage to building surfaces from air pollution for the former and the value of clean water per households for the latter, using willingness to pay analysis – See Box A3)*;

III. The calculation of completed 'dose-response' function, relating pollution changes to effect, for particular receptors, capable of valuation in monetary terms *(multiply the dose (level of pollutant concentration), by the number of receptors (e.g. population), multiplied by the probability of illness/mortality (the DRF) and multiplied by the unit cost (e.g. of a range of illness such as bronchitis and asthma, the number of restricted activity days, hospital admissions, and premature mortality)* – this is the approach applied to the estimation of health benefits from air directives.

Box A3 Willingness to Pay Analysis: An explanation

In many cases the public would be willing to pay a certain amount for a service (e.g. new water supply), or willing to pay for access to clean bathing waters. These represent important consumer preferences. To be able to assess what the WTP is, an extensive survey of consumers is needed to ascertain the value they would attribute to the issue in question, whether clean water, cleaner beaches, reduced risk of bronchitis etc. It is a standard environmental economics tool – known as contingent valuation.

The WTP exercise has now become quite a mature instrument in environmental economics, growing out of market analysis techniques. It is regularly used to assess potential charge rates for water supply across the world, and also used to estimate the value of cultural heritage and bio-foods. It has also been used together with the willingness to accept (WTA) compensation application of the same methodology, as a basis for evaluation required compensation payments, for example with regard to oil spills.

The role of WTP in the current study is present below and in Box A4.

As regards air, a new set of estimates have been made for air related directives, using the EcoSense model (see Part B, Annex B1 for a full description) to capture not only national benefits of implementing the acquis, but also the cross boundary changes in air pollution and association trans-national benefits. This uses available dose response functions.

For water, the analysis approach has been based on a ‘top-down’ approach to estimation using a receptor based approach, because of the lack of sufficient data on pollutants, or where pollution issues are secondary to the availability of the resource/service. For water, therefore, the approach uses a WTP approach.

In addition to air and water, the analysis includes an assessment of the benefits from improved waste management, with particular focus on the benefits from the implementation of the Packaging Waste Directive and the Landfill Directive. This approach has sought to quantify the avoided emissions, multiplied by appropriate unit pollution damage costs.

To carry out the analysis, the insights on the changes in the level of pollution or environmental impacts needs to be complemented by an estimate of the value of the changes to the consumers, affected parties, or affected materials and sectors. Information on the latter element is often based on existing benefits analysis of benefit in the EU or USA, where there is the longest history of such analysis. There are on rare examples of complete benefits valuations carried out for an in candidate countries. Hence, the study team has applied the use of the technique known as “benefits transfer”, where the benefits assessed in one country are transferred, with appropriate weightings to other countries (See Box A4).

Box A4 Benefits transfer and the use of purchasing price parities (PPP)

For the analysis most of the willingness to pay (WTP) values, the dose response functions, and the unit cost values were based on scientific literature from the EU (ExternE work of DGResearch), EU Member States and the United States (see Part B on Air, Part C on Water and Part D on waste for references). There were very few values calculated specifically for the candidate countries. Hence a benefits transfer approach was used – the accepted method in valuations.

Within the benefits transfer analysis, the study team took the unit values and weighted them by the relative per capita purchasing price parities. In other words where an EU value for willingness to pay (WTP) for clean water was used, this was weighted according to the relative PPP of each candidate country and the EU. This leads to the willingness to pay for clean water to be lower in the candidate countries than in the EU, as could be expected. With no PPP weighting one assumes that the willingness to pay for clean drinking water is the same for all countries independent of income levels and purchasing powers. This would suggest PPP weightings make the results more sensible.

This approach becomes more delicate when talking of WTP for avoided illnesses (as surely the actual benefit of an avoided bronchitis is the same independent of whether it concerns a Bulgarian or Czech) – though had an actual WTP survey been carried out in different countries, the one would expect the actual WTP to be different. This basically highlights the problem that if one tries to attribute money values to health impacts, then this leads to ethical debates and problems. This debate is even more controversial when discussing premature mortality (see Box A5 immediately below). In these instances it is important to bear in mind that the aim of a monetary evaluation is to highlight the importance of the problem, and not to suggest that the money value is an equivalent worth to the premature mortality.

Given the above ethical concerns on the use and meaning of monetary valuations, the study team complemented the PPP approach, with a benefits analysis using non-weighted values. This leads to significantly higher benefits estimate than the PPP approach. As the agreed approach to benefits analysis is to ensure that benefits are weighted to PPP (in benefits transfer exercises), and given concern that using non-weighted values would overestimate the benefits, the core results presented here are those calculated using PPP weightings.

A key element of the benefits that have been assessed has been the effect on the health of the population in the candidate countries and, to the extent of reductions in damage elsewhere (e.g. due to reduced transboundary pollution), to the health of citizens elsewhere in Europe. The measurement of the health effects has been shown, from many previous environmental benefit estimations, to be the most significant factor. It is therefore important to recognise the continuing debate concerning the most appropriate way of estimating the monetary value of health and death. We summarise the issues in Box A.5.

Box A.5: "Valuing Life"

Significant controversy surrounds the valuation of impacts to human health, and particularly mortality. This relates to two principal issues: the 'moral' issues of 'valuing life', and the methodology by which values for health impacts are calculated. Much of the reaction to the monetary valuation of mortality stems from the unfortunate choice of terminology, such as 'the Value of a Statistical Life'. This does not mean the 'value of life' as used in everyday language, but is simply a convenient way to summarise information about people's willingness to pay for small reductions in risk. This makes it easier to compare the benefits of measures designed to reduce risks with the associated costs if the aggregate WTP and the number of lives saved are known.

Because of the high percentages of total benefits attributed to improvements in health, the methodologies and assumptions by which these benefits are calculated are of fundamental concern. A principal area of concern is the value placed on changes in the risk of premature mortality. Within this report, the approach taken has been to adopt the VPF (Value of prevented fatality),[11] given the concerns regarding the use of the alternatives: the Value of Life Years (VOLY) approach.

The values used for the assessment in this report are the range of 0.7 MEUR to 2.5 MEUR with a central value of 1MEUR. Given that it is important to use a range to avoid suggesting an unrealistic precision in the result, the study analysis has used the 0.7 MEUR and 2.5 MEUR values for the lower and upper bound calculations. See the Annex of Part B for a fuller discussion.

For the candidate countries, these values were weighed by the relative per capita purchasing price parity rations in the core analysis, and used without any weighting in a sensitivity analysis. The relative PPP is given in Table A.8 below, and ranges from 0.3 in Bulgaria to 0.75 in Slovenia. In other words, and for the sake of illustration, the central VPF value would, when using PPP weighting (as is standard practice in benefits transfer analysis), amount to 0.3 MEUR in Bulgaria. In the "no weighting analysis" the value would be 1MEUR. In the actual analysis, we multiplied the lower value of 0.7MEUR and higher value of 2.5MEUR by the PPP weighting to derive the VPF weighted ranges. The implications on the numerical value of the results is clear, with using EU incomes, the benefits would be much larger. In this report we have focused on the analysis using the weighting; this gives a more conservative estimate, but should be seen in the context of the ethical interpretation.

On the other hand using the PPP weighting means, for example in the context of health benefits, or biodiversity, that the value of a statistical life or an ecosystem is less in the candidate countries than in the EU. This is acceptable in neo-classical economic theory but raises difficult ethical choices in the use of the benefit estimates. It is important to reiterate that the aim of the analysis is to highlight the importance of avoiding pollution caused illness and early mortality. The VSL is therefore an indicator and not a statement of the worth of life.

The calculation of benefits in monetary terms is based on 1999 prices, expressed in Euro. As noted above, the benefits have been calculated to take account of the difference in per capita incomes (proxied by per capita GDP) and the purchasing power in the candidate countries

[11] VPF is the term increasingly used. It represents the same value as VSL (Value of Statistical Life, sometimes know as VOSL), but adopts a different nomenclature.

compared to the EU or the USA where the estimates of pollution damage costs have generally been made. Within the study, sensitivity analysis has been carried out using non-weighted benefits, but not presented here, given that the results are firstly obviously going to be simply larger (and therefore not really needing a separate presentation, interpretation and discussion), and secondly the results would detract from the other results presented.

Table A.8 summarises the GDP/capita purchasing power parities used to convert between EU and candidate countries.

Table A.8: Population, GPD and GPP/Capita/Purchasing Power Parities (PPPs)

	Population	GDP	GDP/Capita/Purchasing Power Parities		
Candidate Country	Million (1999)	Million Euro (1999)	EU15	UK	USA
Bulgaria	8.2	11,600	0.30	0.22	0.15
Cyprus	0.7	8,500	0.75	0.79	0.53
Czech Republic	10.3	49,800	0.39	0.58	0.39
Estonia	1.4	4,600	0.43	0.34	0.23
Hungary	10.1	45,400	0.42	0.50	0.33
Latvia	2.4	5,700	0.43	0.27	0.18
Lithuania	3.7	10,000	0.43	0.29	0.19
Malta	0.4	3,400	0.75	0.65	0.43
Poland	38.7	144,700	0.48	0.36	0.24
Romania	22.5	31,900	0.25	0.26	0.18
Slovakia	5.4	17,700	0.39	0.46	0.30
Slovenia	2.0	18,700	0.75	0.69	0.46
Turkey	64.3	182,700	0.46	0.29	0.19

Source: Calculated from Eurostat estimates of population, GDP and PPPs

Notes: Separate PPPs have been calculated for the UK and the USA because a relatively large number of the estimates of the willingness to pay for avoided damage have been estimated in these countries.

The GDP/Capita/PPPs are used to adjust damage cost estimates to take account of relative incomes and purchasing power. For example an EU estimate of the value of a statistical life would be multiplied by 0.3 to convert to an equivalent value in Bulgaria.

4.0 RESULTS OF THE ASSESSMENT

4.1 Overview of the Qualitative Assessment

The environmental benefits of compliance with the directives are in the first instance the reductions in emissions and pollution, and the greater protection of natural resources from over exploitation and pollution. The consequent improvements in the quality of ecosystems and biodiversity yield benefits that are difficult to quantify. The appraisal of the nature protection directives and review of the current threats to the environment in the candidate countries demonstrates the important benefits that would derive from the implementation the provisions of the directives. Note that benefits are dependent on the provisions being fully enforced.

In addition to the benefits to the natural environment, there are significant benefits to which the populations of the candidate countries are likely attach more value (monetary or otherwise). The environment is not something that exists in isolation from the rest of human experience. The quality of the environment is closely tied to social, physical and mental well-being and the economic performance of companies and whole countries. It is important, therefore, that a consideration is given to where compliance with the environmental acquis will bring benefits to these areas as well. These include:

Direct health benefits to the population from improved air and water quality and reduced exposure to damaging substances. There is a growing body of epidemiological evidence that has linked pollution to ill health. The quantitative assessments, especially for air, provide some measure of the actual number of cases of reduced mortality and morbidity from compliance. The qualitative assessment has highlighted the growing problems from increasing industrialisation and traffic levels. Addressing the growing pollution problems through compliance will generate very significant savings in improved health. This includes the direct cost savings to national health services. Examples include:

- Fewer respiratory diseases and fewer cases of premature death as a result of improved air quality. Benefits are expected across all candidate countries and are particularly important for particulate matter and urban ozone. Reduction in exposure to volatile organic compound (VOC) emissions and dioxins will also offer significant benefits. This pollution arises mainly from emissions from power stations, industry and traffic. Implementing the Large Combustion Plant Directive (LCPD), the Integrated Pollution Prevention Control (IPPC) Directive, the Incineration Directives, Fuel Quality Directives, the VOCs Directive, and the Air Framework Directives will help address these problems.
- Safer environment for children as a result of lower lead emissions, particularly from industry and fuels. These problems can be minimised through the IPPC Directive for industry and the Fuel Quality Directives for lead emissions from transport.
- Better health as a result of less dioxins and heavy metals emitted from below standard incinerators. This can cause cell malfunctioning, either directly, through respiration, or indirectly, though absorption in the food chain. The implementation of the Incineration

Directives will help address this problem and reduce the risk of cancers and malformations.

- Positive health impacts and improved safety from a better management of landfill sites and of hazardous waste as well as the capture of landfill gas, which can cause explosions or leakages (where the landfill is not a technically secured landfill). These benefits result from implementing the requirements of the Landfill Directive.
- Fewer cases of gastric illness and irritations to skin caused by poor water quality and high concentrations of contaminants in polluted rivers, lakes and coasts. Implementing the Urban Waste Water Treatment Directive can help avoid these negative impacts on health. This will be particularly beneficial where the downstream rivers, lakes and coastlines are of significant recreational value (e.g. coasts of Cyprus, Malta, Turkey).

Eco-system Benefits

- Better protection for eco-systems, which are under particular pressure from air and water pollution and from certain economic activities (e.g. road constructions and intensive agriculture). Acid rain is a significant pressure on land-based eco-systems, such as the Black Triangle[12] – parts of Poland, Czech Republic and Germany. This problem will be reduced with the full implementation of EU air directives.
- Less damage for water based eco-systems, such as the Danube Biosphere Reserve, the Black Sea, and the Baltic Sea through improved water quality. The full implementation of the Directive on Discharge of Dangerous Substances to water and Urban Waste Water Treatment Directive should reduce pressures significantly.
- Positive impacts for eco-systems from improved waste management. For example, less emissions of heavy metals and dioxins from incineration and less groundwater pollution from the illegal dumping of waste as well as from untreated waste. This damage can be reduced through the implementation of the waste directives.
- Finally, the implementation of the Habitats Directive may help reduce the damage to habitats from encroaching economic activities such as uncontrolled urbanisation in Turkey, intensive logging in the Birzai Forest of Lithuania or intensive agriculture practices on and around the designated protected areas around the Danube Delta.

Resource benefits: Compliance also provides benefits from increasing the productivity of commercially exploitable environmental resources. These include fisheries and forestry. Damage to these environmental resources (e.g. through pollution) reduces the economic benefit that can be derived from them. Compliance with the acquis may help to safeguard these resources and so maintain (or even enhance) this sector of the economy.

Social benefits: It is increasingly the case that social benefits are seen to derive from the maintenance of a clean environment. Communities in polluted environments may feel excluded from the socio-political structures of society, or simply undervalued. A clean environment also brings general benefits to communities as they interact with their

[12] There are already signs of significant improvement from activities in the recent past.

environments, e.g. through recreation at available bathing sites, rivers, nature sites. Such benefits are not to be underestimated, particularly in candidate countries where social cohesion is an important objective within the overall process of economic and political transition. It is also important to note that such benefits are a clear signal of the benefits of EU membership more widely and, therefore, assists both candidate country governments and EU institutions in explaining the benefits of the enlargement process. Quality environments can also attract tourists from the EU and support the EU cohesion process.

Furthermore civic society will benefit from the increased communication of information on the environment, increased consultation and involvement (e.g. consumer involvement in the packaging waste directive will help increase awareness of their role and impacts on the environment). Finally, employment can be supported by environmental expenditure (see below), supporting societal stability.

Wider Economic benefits: while much attention is given to the costs of compliance with the acquis for certain industries affected, it is also important to stress that some industries will benefit from compliance. The most obvious group are those that may provide new environmental services, e.g. those producing clean technologies, clean fuel, etc. There are also many industries, which rely directly on a clean environment (e.g. the tourist sector which will benefit from clean bathing waters, well maintained nature reserves, etc). Additionally, many industries use environmental resources such as water and will benefit from such resources being as free from contamination as possible. These wider economic benefits are many and various as is shown in a consideration of each directive.

- Economic development can be supported through the proper implementation of the EU directives. Notably the Bathing Water directive should support the tourism industry as clean beaches are certified. Furthermore, many companies should face lower treatment (e.g. less pre treatment of water needed with better surface and ground water quality) and maintenance costs from the implementation of the directives. Furthermore, investment in and subsequent operation and maintenance of new infrastructure will lead to investment in the local economy, with positive knock-on effects on local and regional economic development, and supporting employment.
- The existence of clean air and water, combined with environmental infrastructures (connection to water supply, waste treatment and waste collection system) can improve the “locational quality” of an area and help attract investment. “Locational quality” is a key driver for inward investment and for retaining high skilled labour, and while not possible to quantify or monetise, is a fundamental element of local and regional development policies, policies to attract foreign investment, and indeed a fundamental need for sustained economic development. Reduced demand for landtake, greater emphasis on efficiency of materials use, increased agricultural yields due to decreased air and water pollution, enhanced esthetical value of the environment (and increased tourism) can lead to wider development benefits if the waste directives are implemented. Also, increased emphasis on recycling and composting can encourage collection / reprocessing / secondary material manufacturing activities to develop, hence an employment benefit.

Table A9 presents an overview of the benefits of full implementation of the acquis, directive by directive. An overview of the benefits of the full implementation of the acquis in the candidate countries in relation to pollution and natural resource pressures on water, waste, air and nature protection for each of the 13 candidate countries has been combined with the results of the monetary analysis.

Table A9. Overview of the Qualitative Benefits of Compliance

	Overview of Benefits				
Directive	**Health Benefits**	**Resource Benefits**	**Eco-systems**	**Social Benefits**	**Wider Development**
Air Quality					
Air Quality Framework + daughters: PMs, SO2, Pb, NOx	***	***	***	**	**
Tropospheric Ozone Pollution	**	**	**	**	**
VOC-Solvents	**	*	**	*	*
Regulation - Ozone-Depleting Substances	*	*	*	*	
Lead Content of Petrol, Quality of Diesel	***	-	*	**	*
Industrial Pollution Control					
Air Pollution from Industrial Plants	Included in IPPC				
Large Combustion Plants	***	**	***	***	**
IPPC	***	**	***	***	**
Waste Management					
Framework Directive on Waste	**	*	**	**	**
Titanium Dioxide and daughters	**	*	*	*	
Incineration of Waste	***	**	**	**	*
Landfill	**	*	**	**	*
Disposal of Waste Oils	*	**	**	*	*
Disposal of PCBs and PCTs	**	*	*	*	
Sewage Sludge	*	*	*	*	*
Batteries and Accumulators	*	*	**	*	*
Packaging and Packaging Waste	*	*	**	**	*
Water Quality					
Water Quality Framework	*	*	***	**	**
Dangerous Substances	**	**	***	***	**
Urban Waste Water	***	**	***	**	*
Nitrates from Agricultural Sources	**	**	**	**	*
Bathing Water	**	**	**	**	***
Drinking Water	**	**	**	**	*
Surface Water for Drinking	**	**	**	*	*
Ground water	**	**	**	*	*
Fish water	**	***	**	**	**
Shellfish Water	*	**	**	*	*
Nature Protection					
Habitats	-	*	***	***	**
Wild Birds	-	*	***	***	**

Key: Very Significant Benefits: *** ; Significant Benefits: ** ; Some Benefits: *

4.2 Summary of the Quantitative Benefits

4.2.1 Overview

The analysis of the impacts from the implementation of the EU acquis communautaire in the candidate countries shows that there are extensive benefits both in reduced pressures on the environment (though reduction in pollution emissions and deposition) and subsequently reduced impacts (health). Key quantified impacts include:

- **Air:** The total reduction of emissions of particulates from the candidate countries is expected to amount to between 1.8 and 3.3 mt in 2010. The relationship of exposure to particulate emissions and the risk to human health of increased respiratory diseases and early mortality suggest between 15000 and 34000 fewer cases of early mortality across the candidate countries in 2010.
- **Water:** Across the candidate countries, most households are expected to benefit from improved drinking water quality and confidence in this quality. Particular benefits will accrue to those currently without supply as new connections are put in place - for example between 20% and 30% of all households in Turkey, Bulgaria and Estonia currently are not connected, many of which could stand to gain from infrastructure extensions. The benefits include issues of consumer preference on issues such as better taste, colour and smell of water, confidence in quality, as well as health improvements due to reduced contamination. Similar benefits are expected from improved bathing water quality.
- **Waste:** Methane emissions will, through the Landfill Directive, fall by some 0,6 to 6,4 million tonnes annually by the year 2020[13]. The Directive on Packaging Waste will also imply that the amount of packaging waste recycled by all candidate countries will increase by 3.7 million tonnes per year by 2020. In addition, in spite of an estimated 2% growth in waste generation, the Landfill Directive is calculated to lead to a reduction of waste disposed in landfills from around 59 million tonnes in 1998 to between 20 and 35 million tonnes in 2020; implementing the Landfill Directive (under the maximum recycling and composing scenario) will lead to around 54 million tonnes of diverted bio-degradable waste being recycled or composted by 2020.
- **Nature:** The size of protected areas, as percentage of total country surface, will increase and the level of protection of these areas will in many cases improve. The forecast increases in protected areas stems primarily from national strategies and plans rather than the acquis, but the issue of the level of protection will be supported by the appropriate implementation of the acquis. The increase in protected area is expected to range from: 26 percentage points (pp) in Slovenia (from 6% of total surface area to 32%), 10 pp in Malta (from 18% to 28%), 8 pp in Lithuania (from 11% to 19%), and around 2,5 pp in Bulgaria (5% to 7,5%) and Estonia (16% to 18,3%).

[13] The landfill directive provides for gradual implementation (with staged targets) with all provisions needed to be carried out by 2020. This is why this section uses 2020 rather than 2010 even though full implementation by some countries is possible by 2010.

4.2.2 Air

The study has assessed the extent of the benefits from lower emissions for the following pollutants: particulates, sulphur dioxide (SO2), nitrogen oxides (NOx), volatile organic compounds (VOCs), carbon dioxide (CO2), carbon monoxide (CO), heavy metals and Tropospheric ozone. The analysis does not cover dioxins, traffic related ozone emissions or methane (CH4). The results are therefore underestimated as dioxins and ozone have significant impacts on health and methane is an important greenhouse gas. The main benefits arise from lower emissions of particulates (PM10), of the acid gases SO2 and NOx, ammonia (NH3) and volatile organic compounds (VOCs). Carbon monoxide and carbon dioxide are considerably less important.

EU directives will reduce the emission of particulates by some 1,8 to 3,3 million tonnes in 2010. By that year, total emissions of particulates are expected to range from 0,4 to 1,8 million tonnes, with full implementation. Without implementation of EU directives, this would amount to 3,7 million tonnes. This reduction will reduce the risk of respiratory diseases (e.g. bronchitis, asthma), hospitalisation and premature deaths. The study suggests that between 15.000 and 34.000 cases of premature deaths will be avoided every year across the candidate countries through full implementation of EU directives in 2010[14]. Table A10 gives an overview of the benefits of avoided morbidity impacts and Table A11 the avoided early mortality (see Part B for more details)

Table A.10: Physical Morbidity Impacts in year 2010

Morbidity impacts (equivalent number of chronic bronchitis cases avoided each year)	*Low estimate*	*High Estimate*
Bulgaria	437	1402
Cyprus	99	174
Czech Republic	1528	3305
Estonia	170	527
Hungary	1589	5218
Latvia	208	1859
Lithuania	1061	1546
Malta	21	37
Poland	5667	10137
Romania	2493	6072
Slovakia	1304	8154
Slovenia	156	1417
Turkey	26970	134880
Total	**41703**	**174728**

[14] The results, when compared to existing data on mortality from respiratory diseases, do not seem at odds. While data is only partial across the candidate countries, and does not distinguish from different pollution exposure, it does offer a helpful comparison. There were 2955 recorded cases of Mortality through trachea, bronchus & lung cancer in 1998 in Bulgaria, 18890 in Poland and 8100 in Romania. These are higher than both the lower and the upper estimates of avoided early mortality from respiratory diseases, though only slightly higher for the upper emissions reduction scenario.

Table A.11: Physical premature mortality impacts avoided in year 2010

	Lower reduction scenario (Gothenburg Protocol/10% reduction Prot. pollutants, 50% PM10 reduction).	**Upper reduction scenario** (Maximum Feasible redn/50% Protocol pollutants, 90% PM10 reduction).
Bulgaria	357	1163
Cyprus	64	126
Czech Republic	996	2216
Estonia	136	635
Hungary	998	2704
Latvia	171	443
Lithuania	101	225
Malta	11	41
Poland	7115	14344
Romania	2423	7199
Slovakia	714	1653
Slovenia	93	233
Turkey	1820	3468
Total	**14999**	**34450**

Without EU directives, total SO2 emissions of the candidate countries are expected to stand at some 7 million tonnes in 2010. Full implementation of the EU directives (not taking into account the currently discussed new Large Combustion Plant Directive) will reduce these emissions to some 4 to 5 million tonnes. Likewise, NOx emissions are expected to fall from around 3 million tonnes in 2010 to 2 million tonnes through compliance with EU directives. This reduces the damage to buildings, crops as well as the incidence of respiratory diseases.

Some examples of these benefits include:

- Between 43.000 and 180.000 cases of chronic bronchitis will be avoided in 2010 through the full implementation of EU air directives. A large number of these relate to Turkey, primarily due to the use of low quality lignite in power stations.
- As mentioned above, between 15.000 and 34.000 cases of premature deaths can be avoided through improved air quality. Poland is expected to benefit the most, with between 7.000 and 14.000 fewer cases in 2010.
- Building surfaces "age" less quickly when they are not exposed to SO2 emissions. For example, lower air emissions should reduce the building surface of the Czech Republic needing maintenance by some 2,6 million square meters in 2010.
- Crop yields can increase when exposed to less SO2 - for example, the implementation of the EU directives may result in a 5% increase in the yield of wheat in Bulgaria in 2005.

4.2.3 Water

The study has assessed the extent and value of the following benefits:

- Benefits from the availability of drinking water and its improved quality.
- Recreational benefits from cleaner coasts, lakes and rivers for bathing.
- Benefits to eco-systems from less pollution into water as well as benefits from improved quality of water resources that are used for commercial purposes.
- Transboundary benefits are reflected to a certain extent, given that all candidate countries are included in the analysis.

Given data availability, the study has not included the following benefits:

- Benefits to industrial abstractors, agriculture and aquaculture, although these are likely to be significant.
- Benefits to EU Member States.

Extent of the benefits

Households are expected to benefit from improved quality of drinking water and in some cases new access to (quality) drinking water. Examples of benefits include:

- For most households already connected (around 59 million across the candidate countries), there will be significant benefits from improved drinking water quality.
- In Turkey, around 6 million households (29%) are expected to benefit from new connection to drinking water supply systems with assured quality.
- In Bulgaria and Estonia, these values are similarly high (25% and 30% of all households respectively), while in other countries, a lower share of all households benefit.

River quality

The implementation of EU directives will significantly improve the quality of rivers in the candidate countries. Details are given in Table A12 (and further details in Part C). Examples of benefits are:

- In Bulgaria, 23 rivers are of ‘good’ quality, 18 of ‘fair’ quality, the rest is of either ‘bad’ or ‘very bad’ quality. After compliance with EU water directives, 41 rivers are expected to be of ‘good’ and 59 of ‘fair’ quality. In the other candidate countries, similar results are expected.
- The Czech Republic has the biggest river length of all the candidate countries (76.000 km). At the same time, 10% of rivers are of ‘fair’ quality, 10% of ‘very bad’ quality, while the remaining 80% are of either ‘poor’ (40%) or ‘bad’ (40%) quality[15]. Compliance

[15] This applies the Czech Republic’s classification of water quality. According to this classification, "poor" quality is better than "bad" quality. The classification of river quality varies somewhat across candidate countries, so a country to country comparison should be seen in this context to avoid misleading interpretations. The important issue is the benefit within a country from improvements in river quality.

with EU water directives will improve this situation considerably: 10% are expected to be of 'good' quality, and all rivers of 'poor', 'bad' or 'very bad' quality are expected to improve to fair quality after successful implementation.

Table A.12: River quality classification in candidate countries (% of rivers), before and after implementation of water directives (for the reduction of pollutant discharges)

	Classification before compliance with water directives						Classification after compliance with water directives	
	Good	**fair**	**poor**	**bad**	**very bad**	**data from**	**Good**	**Fair**
Bulgaria [1]	23	18	48	11		1998	41	59
Czech republic [2]		10	40	40	10	1998	10	90
Cyprus	No rivers							
Estonia	No data							
Hungary	No data							
Latvia [3]	25	36	35	4		1997	61	39
Lithuania	No data							
Malta	No rivers							
Poland [4]	20	40	25	15		1995	60	40
Romania [5]	59	26	6	9		1999	85	15
Slovak republic [6]			45	28	27	1998	0	100
Slovenia [7]		45	48	7		1998	45	55

Sources: 1. see Part C for references

Note: As noted in the table, data for some countries was not available.

Recreational use of water

- The implementation of the Urban Waste Water Treatment Directive will lead to an improvement in the quality of coastal waters, rivers and lakes, particularly as result of reduced euthrophication following better treatment of waste water. Discharges of nutrients are expected to fall by between 33% in the Czech Republic to 67% in Poland and phosphorous discharges from 38% in Slovenia to 71% in Poland. This creates better opportunities for recreational activities, including tourism, as well as reducing danger to fish stocks.

4.2.4 Waste

The EU waste directives will lead to major changes in handling, treatment and disposal of waste in the candidate countries. The candidate countries have a wide range of ways in which they can choose to implement the set of waste directives. For example, they can choose to give priority to recycling or to incineration. This choice will affect the extent and value of the benefits arising from each directive. It is therefore not always possible to identify exactly what will occur as a consequence of a specific directive.

The main benefits from implementing the waste directives are:

- Lower pollution to groundwater and surface water from leakage of unprotected landfills and, as a result, lower risks of contaminating ground water aquifers and surface water, and hence lower the risks of contaminating drinking water.
- Reduced health and explosions risks as well as lower impact on global warming as methane emissions from landfills are captured and used to generate energy (with economic benefits). Existing landfill sites will have to be upgraded or closed according to specific standards and illegal dumping sites also properly closed.
- Benefits to eco-systems and other environmental resources as emissions from waste activities into air, water and soil are reduced and the recovery of energy is increased through the Incineration Directive.
- Increased efficiency in the use of material and reduced production of primary material as a result of higher levels of recycling. This is a result of the targets of the Packaging Directive as well as diversion targets from the Landfill Directive.
- Lower costs for waste collection, treatment and disposal as less waste will be produced.
- Better management and monitoring of waste streams through the Waste Framework Directive.

EU waste directives will also help avoid:

- Pollution into air, soil and water (particulates, dioxins, heavy metals from sewage sludge, PCBs/PCTs, waste oil) and ecological risks from waste treatment sites and hazardous waste.
- Respiratory diseases and noise nuisance to local population, risks to health from air pollution and contaminated soil.

Extent of the benefits

- The full implementation of the Landfill Directive will lead to a reduction of methane emissions (captured) of between 0,6 and 6,4 million tonnes annually by the year 2020.[16]
- In spite of a 2% growth in waste generation, the Landfill Directive is estimated to reduce the waste disposed in landfills from some 59 million tonnes in 1998, to around 35 million tonnes by 2020 (instead of 89 million tonnes) if the candidate countries grant priority to recycling and around 20 million tonnes if incineration is chosen as the preferred option. Under the maximum recycling and composting scenario, around 54 million tonnes of diverted bio-degradable waste will be recycled or composted by 2020.
- In light of the Packaging Directive, recycling levels will, by the year 2020, have increased by 1,6 million tonnes for paper, around 39.000 tonnes for aluminium, and for all the recyclables together, around 3,7 million tonnes.

[16] As noted above, the landfill directive provides for gradual implementation (with staged targets) with all provisions needed to be carried out by 2020. This is why this section uses 2020 rather than 2010.

Figure A4a presents the country specific increases in paper recycling and Figure A4b increases in total recycling from the Packaging Directive; see Part D for further details on other recyclables.

Figure A.4a: Packaging Directive: Increase in Paper Recycling by 2020

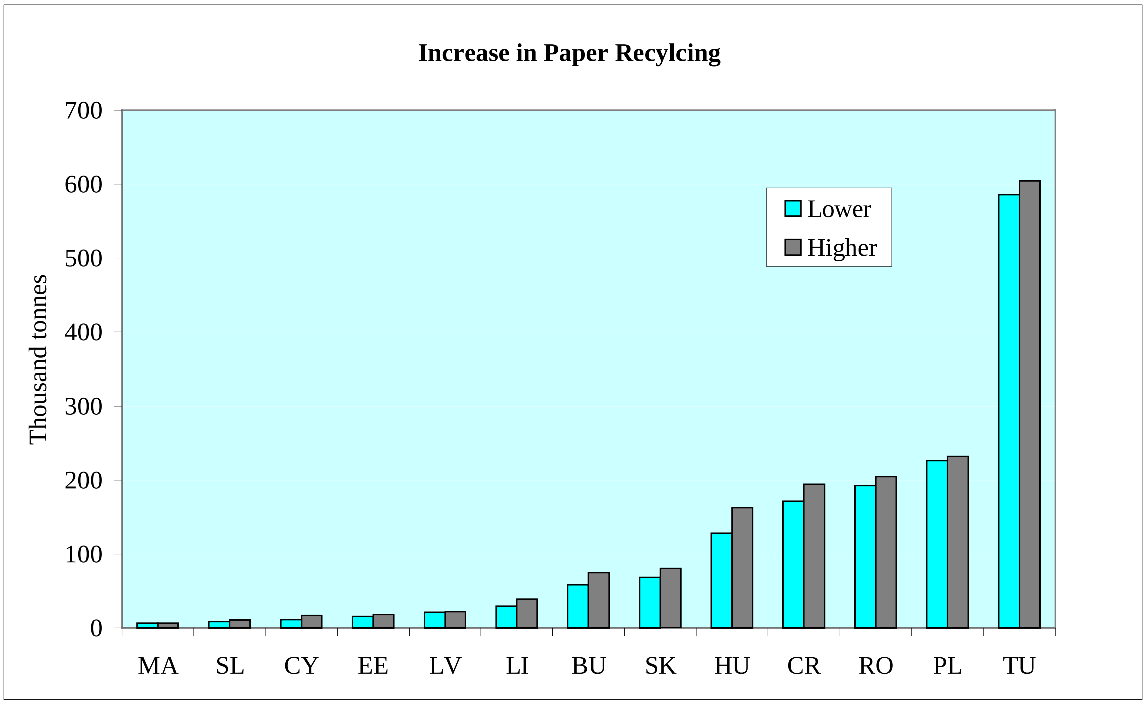
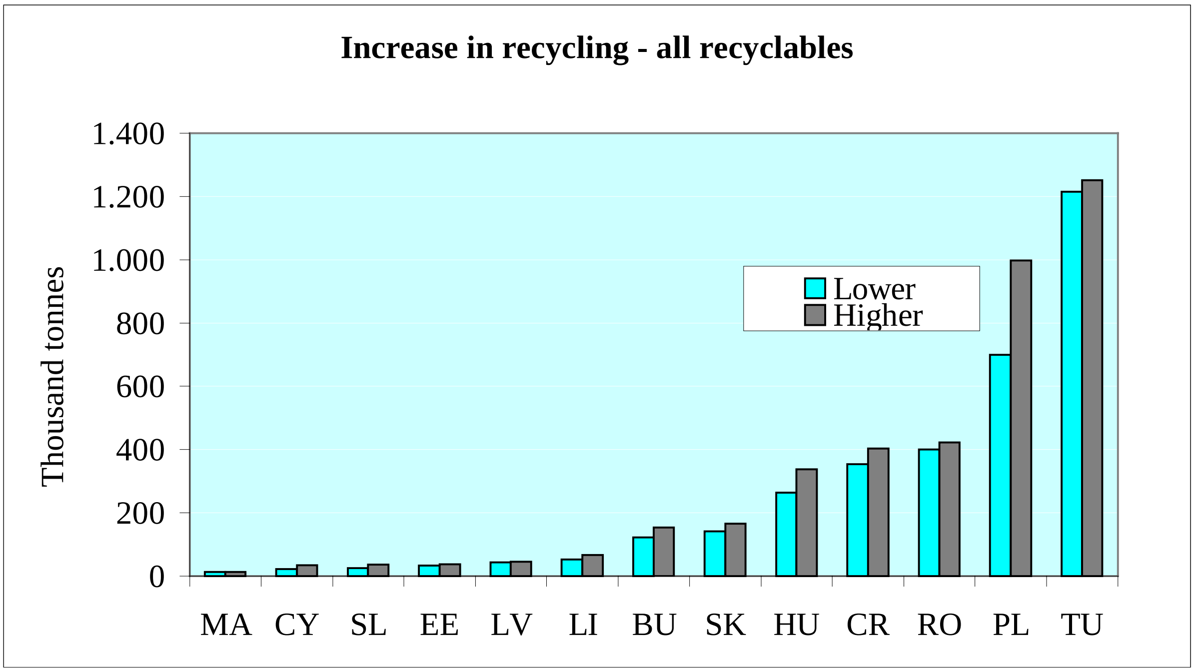


Figure A4b: Packaging Directive: Increase in Recycling – Total (by 2020)



4.2.5 Nature

The benefits arising from the implementation of EU directives on nature conservation are mainly related to the setting-up of the Natura 2000 Network of special conservation areas in the candidate countries. Biodiversity and ecosystems will also benefit from other directives of the EU environmental legislation, for example through better air and water quality (which reduce pressures on protected areas), but these are not covered in this section.

The main threats to ecosystems and bio-diversity in the candidate countries are:

- Acid rain and soil pollution from industry.
- Practices in agriculture, hunting, fishing and forestry that do not take environmental concerns into account.
- Construction linked to infrastructure (e.g. roads) and human settlements.

Implementing the Habitats and Wild Birds Directives will help address some of these problems by:

- In many cases, increasing the surface of protected areas.
- Raising the level of protection within existing protected areas.
- Identifying species to be protected.
- Adopting specific protection measures against identified threats faced by each designated area (e.g. forbidding pesticide use, increasing enforcement).

Extent of benefits

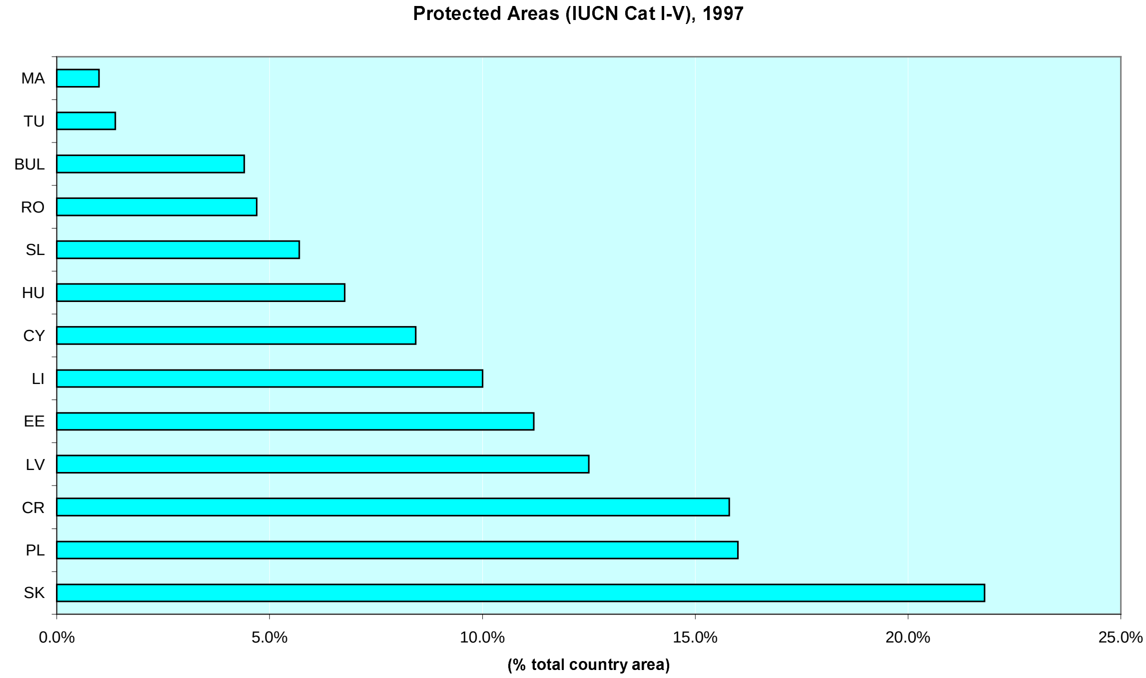
From 1997 to 2020, the size of protected areas (as a percentage of each country's total surface) is expected to increase, and the level of protection of these areas will in many cases be strengthened. While the increase in area is primarily driven by national strategies and concerns, the improvement in the level of protection will be influenced by the implementation of the acquis communautaire. Some examples of projected increases in the protected areas include:

- Bulgaria: + 2,5 percentage points, from 5 % to 7,5% of Bulgaria's total surface.
- Estonia: + 2,3 percentage points, from 16% to 18,3% of Estonia's total surface.
- Lithuania: + 8 percentage points, from 11% to approximately 19% of Lithuania's total surface.
- Malta: + 10 percentage points, from 18% to about 28% of Malta's total surface.
- Slovenia: + 26 percentage points, from 6% to 32% of Slovenia's total surface.

The second major benefit is the protection of threatened species. In the candidate countries, these species, in particular mammals, represent a substantial part of the countries' total species population. Examples include: 19% in Romania; 15% in Turkey; 14% in Slovenia; 12% in Poland; and 7,4% in Lithuania.

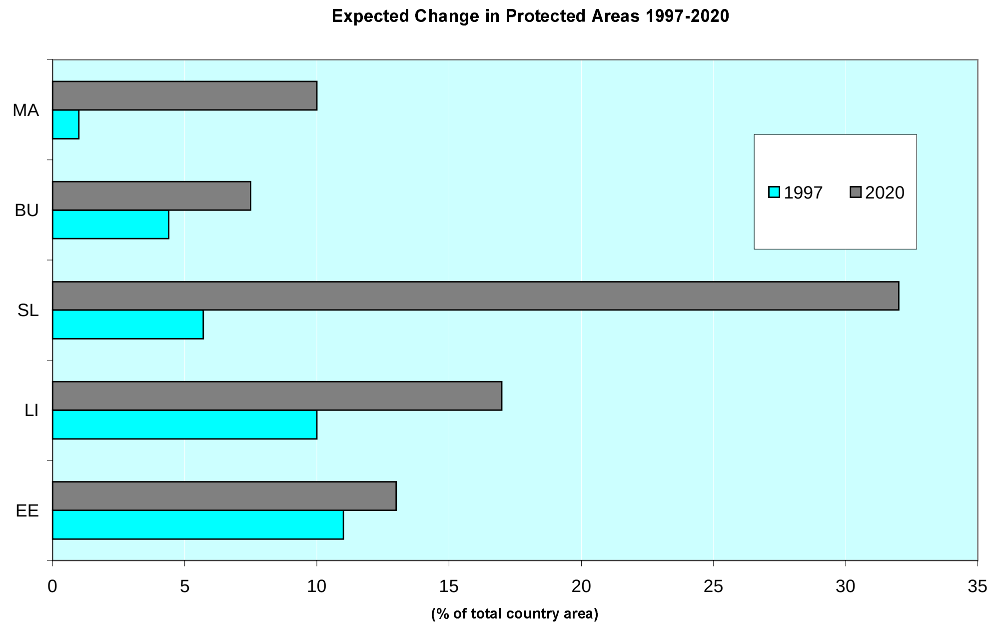
EU directives on nature protection will provide better protection for these and other species, including plant species. (see Figure A6).

Figure A5 Protected Areas as Percentage of Total Country Area, 1997



Source: World Conservation Monitoring Centre (1998-1999) & Candidate Countries' Experts.

Figure A.6 Expected Change in Protected Areas 1997-2020



Source: World Conservation Monitoring Centre (1998-1999) & Candidate Countries' Experts

4.2.6 Socio-economic: Employment Analysis

Many socio-economic benefits are likely to arise from the full implementation of the EU acquis communautaire in the candidate countries. These will include:

- Support for **employment** in the eco-industries through increased investment and more developed infrastructure (with associated higher operation and maintenance activities);
- Improvements in the **eco-efficiencies** of industry as new processes are put in place and existing activities, where relevant, made more sustainable – this will lead to a reduction in the resource intensity of production processes, and one could expect sector and national improvements in energy and water use per unit GDP or per unit value added. One could also expect a reduction in the amount of use of primary raw materials in the production process as reuse, recycling practices and pricing policies take effect. It is clear from existing statistics that the eco-efficiencies of many industries in the candidate countries lag those in many European Union Member States;
- The improvements in eco-efficiencies will undoubtedly help the **competitiveness** of many of the industries in the candidate countries, and support them in the process of entry to the competitive European internal market. This will not only support the economy, but help address employment, and national balance of payments issues.
- Improvements in the **pollution intensities** of the production processes – one could expect a reduction in the amount of pollutants (e.g. CO2, NOx, SOx, dangerous substance discharges to water, waste arisings) associated with a unit of GDP or value added of the economy as a whole and certain sectors in particular. As with resource intensities, the pollution intensities of production are often higher in the candidate countries than in most of the EU Member States[17].
- It is less clear whether the energy use, natural resource use and pollution levels per capita will rise of fall. It is clear that the intensity for a given consumption would drop, but this will be partly (if not wholly) offset by changes in consumption patterns.
- In addition, there are clearly going to be some positive **enterprise-culture** developments that can lead to some economic benefits and avoided costs. This includes for example the likely impact of implementing the Seveso II (ComaH) Directive, as this should help reduce the likeliness of accidents and reduce the costs of accidents (see Part B)

The above is but a short list of the type of socio-economic benefits likely to accrue through the proper implementation of the acquis and parallel national efforts for the development of the economy. The study team investigated the possibilities of developing robust estimates for several of the above. The issue most amendable to a quantitative assessment was that of the impact of employment. This is presented in detail in Part F of this study - including not only the results, but the methodology and assumptions also. This focuses on the level of

[17] See EEA (2001): *Environmental Signals 2001*, European Environment Agency Regular Indicator Report. Environmental Assessment Report No 8.

employment that is likely to arise from the expected environmental expenditures required to implement the acquis – with a view of obtaining an “order of magnitude” estimate that allows the importance of the issue to be highlighted (summary results presented further below). Additional work by the European Commission is looking at a more elaborated analysis.

The study team concluded that it would not be possible to derive a quantitative analysis of the impacts on competitiveness, on the eco-efficiencies of production and the economies, or indeed on the pollution intensive of consumption, given, in particular, the difficulties in predicting likely economic development paths, industry restructuring plans, and consumer spending patterns. This is a non-trivial exercise and a rough estimate here would undermine the credibility of the more robust answers presented for other quantitative analysis within the study. However, while no full analysis is carried out, where robust insights were possible, these were presented in the relevant parts of the report (for example a look at the reduction of primary materials use is presented in Part D on waste).

Summary Results

The total number of jobs that could be supported by environmental expenditure could reach 1.86m across the candidate countries of which around 480 thousand would relate to capital expenditure. These values clearly present a strong message: a large number of jobs can be supported by environmental investments in the candidate countries.

The number has, however, to be seen in context. The basic assumption driving the analysis is that with lower wages, more labour will be used as a factor of production. This clearly will be the case, but only to some extent. In some cases there are technical limitations to how many people can be employed – to put it simply, no matter how cheap labour is, there is only one driver of a waste truck. The values should therefore be seen as an overestimate. However, using EU wage rates would have led to an underestimate, as clearly activities will be more labour intense with the lower wage rates in a number of candidate countries.

Furthermore, this analysis has only looked at the gross job creation, which, while important in employment market analysis for eco-industries, ignores the fact that the expenditure on environmental matters, will imply a reduced expenditure in other areas, and consequently a reduced level of employment elsewhere. It is clear that the net job creation would be significantly lower than the gross values noted above and there may well be no net job creation. The analysis here is but a first cut analysis to highlight the importance of this issue. A fuller treatment of the employment implications of environmental investment is being carried out by the European Commission[18].

[18] The study - *Analysis of the EU Eco-Industries, their Employment and Export Potential* – is likely to be available towards the end of 2001.

4.3 Summary of Monetary Benefits

4.3.1 Context and meaning

The monetary assessment of the effects of compliance provides a measure of the benefits which follow from the implementation of the environmental directives as described in the environmental chapter of the *acquis communautaire.* This measure does not capture the full range of the benefits and provides only a partial indicator of the consequences of approximation, as indicated by the benefits pyramid (Figure A.2 above). To reiterate, the benefits that have been valued (the relation to the specific directives are given in Parts B, C and D) are:

A) Air Pollution
- ⇒ Benefits to human health
  - Avoided early mortality and illnesses (bronchitis, asthma, hospitalisation days, reduced activity days etc)
- ⇒ Reduced costs of building surface maintenance
- ⇒ Reduced damage to crops

B) Water
- ⇒ Benefits to consumers of clean drinking water
- ⇒ Benefits of clean beaches and surface waters
- ⇒ Benefits of clean rivers for non–recreational use
- ⇒ Angling benefits (but not included in final aggregate given concerns of double counting)

C) Waste
- ⇒ Benefits of reduced primary raw material use
- ⇒ Benefits of methane capture from landfills
  - Avoided global warming contribution
  - Energy generation (economic benefit and benefit of avoided emissions)
- ⇒ Benefits of reducing the amount of waste (biodegradable component) going to landfills
- ⇒ Benefits from the Incineration Directive (CR only)

The study team considers that the coverage of benefits was more comprehensive (though still with some important gaps given data availability) for air, than it was for water, and more comprehensive for water than it was for waste. Hence caution should be exercised when considering comparing benefits across environmental media.

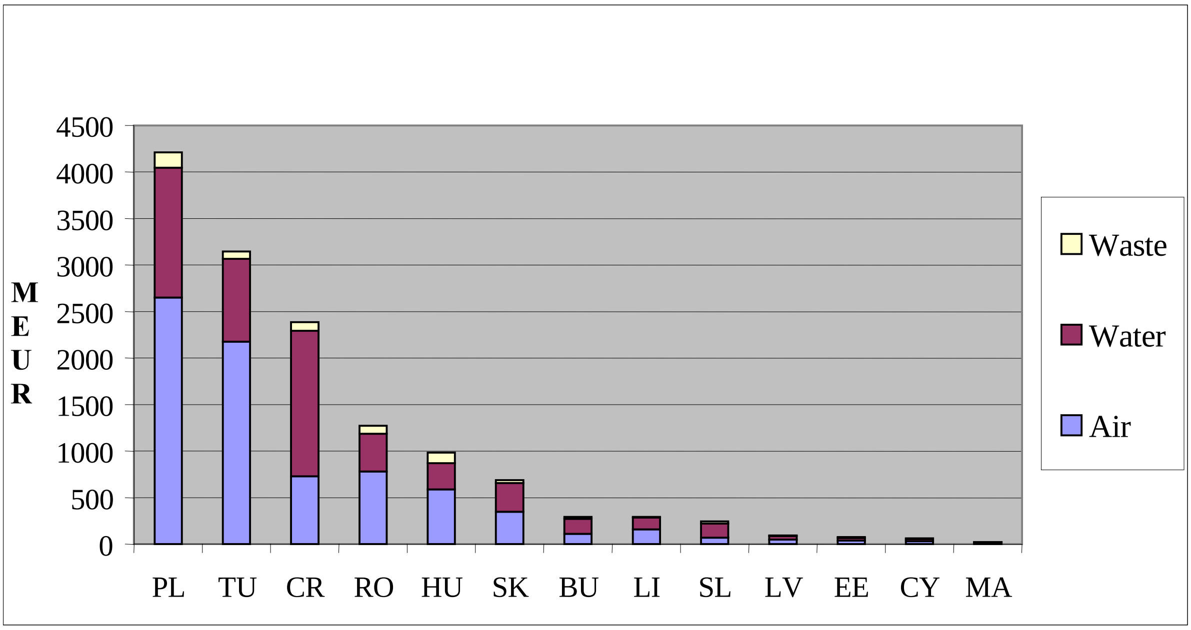
The benefit value calculated is an important indicator of the important of the benefit. It does not, however, represent the change to GDP that would occur upon full implementation. This is because the issued values in the benefits valuation include benefits (e.g. benefits of avoided illness that include not just hospitalisation, or lost working days but also consumer personal benefits of not falling ill) that are not captured by the purely economic GDP indicator. An important share of the benefits value of this report, present a statement of the strength of peoples' preference and do not necessarily translate into everyday market economic terms, though in many cases help to reveal the market or potential market otherwise hidden. In short, the final benefits value is an important indicator of the importance of the benefits that will arise from implementing the acquis, but are not fully equatable with GDP or real costs.

The approach to monetisation separates the annual benefits, which follow from full compliance from the present values of the benefits over the benefit period (2000 – 2020), which depend on the timing of implementation and the choice of discount rate (see section on full period benefits further below). This approach allows an explicit treatment of both the environmental effects associated with directives and of the choice of implementation strategies.

4.3.2 Annual Benefits upon full compliance

Where possible and sensible, an economic value has been estimated for these benefits. The annual benefits arising from full implementation amount to between 12,5 and 69 billion EUR (Table A13). At national level, Poland, Turkey, the Czech Republic and Romania stand to benefit from full implementation the most (in absolute terms, see Figure A7 for lower bound estimate).

Figure A.7 - Annual Value of Benefits for Full Compliance: Lower Estimate



A single number cannot be given as this would be misleading, the wide range underlines the uncertainty of the value[19]. The range should, however, be seen as a good indicator for the level of the benefit. For the monetary analysis, the study focussed slightly more on the low figures, as any policy implications that are likely to arise from the lower estimate would arise doubly so for the higher estimate. The lower estimates do, however, should be seen in the

[19] Value of illness, value of early death, cost of global warming are each generally given in large ranges, depending on the method used to estimate them.

conjunction with the higher benefit, to avoid losing valuable insights. In some cases it is particularly important to look at the higher value (e.g. drinking water and some aspects of waste), and these are noted throughout the report.

Benefits from reduced air pollution accounts for around half of the total benefits for both the lower and upper estimate. However, it should be kept in mind that the benefits from water and waste directives are less exhaustively captured by the monetary valuation and that the benefits from nature protection are not covered.

For the lower estimate the waste benefits assessed are much smaller than those for the air and water related benefits in the lower bound estimate. However, in the higher bound estimate the benefits from implementing waste related directives is of the same scale as the benefits from the water related directives.

However, it is the case that the benefits assessed for the water and waste directives cover fewer of the actual benefits and therefore the final assessed value is not fully representative of the total benefits likely to accrue from the implementation of the acquis in the environmental domains. Furthermore, it was not possible to assess the benefits from the implementation of the nature related directives, and this clearly does not indicate that there are no benefits.

It is therefore important to underline that fact that the coverage of benefits in the monetary evaluation is lower for waste than for water and lower for water than for air. It is clear that the actual benefits from the implementation of the waste related directives are significantly higher than the monetary value that has been estimated.

Again a simplistic comparison of the benefits value for air, water and waste will lead to misinterpretation of the meaning. The monetary results for each environmental media should be seen in the context of the full range of benefits likely to accrue as given in the qualitative description.

Table A.13: Annual Benefits of Full Compliance, by Media, by Candidate Country (Million EUR)

	Annual Benefits of Full Compliance (million EUR)							
	Air		**Water**		**Waste**		**Total**	
Country	Low	High	Low	High	Low	High	Low	High
Bulgaria	110	1130	160	435	20	680	290	2240
Cyprus	30	140	25	100	8	75	65	310
Czech Republic	730	3600	1560	2475	95	1150	2390	7220
Estonia	40	210	27	100	10	180	75	490
Hungary	590	4100	280	1080	115	1900	985	7080
Latvia	50	320	40	140	5	110	95	570
Lithuania	160	820	125	280	6	205	290	1300
Malta	8	40	13	47	3	40	24	130
Poland	2650	15400	1400	3280	165	2750	4210	21400
Romania	780	5850	405	1250	85	2650	1270	9800
Slovakia	350	2250	305	680	30	440	690	3370
Slovenia	70	475	150	350	25	290	240	1120
Turkey	2180	9700	880	3400	77	1850	3140	14950
Total	**7700**	**44000**	**5380**	**13600**	**650**	**12300**	**12500**	**69300**

Note: Total may not add to the sum of the parts given rounding.

These values relate to the full benefits to the candidate countries - from both own action and as a result of other candidate countries implementing the EU directives, with the exception of Turkey for which only benefits from domestic actions are covered.

It would be misleading to present a single central estimate as this would implicitly suggest a very accurate knowledge of the relationship between pollutant, impact and monetary benefit. Hence, the lower and upper bounds reflect the bounds of confidence in the results given methodological uncertainties.

Benefits: per capita and per unit GDP

Per Capita Benefits: When looking at these benefits in relation to the population and GDP of the candidate countries, the picture is a little different. The benefits as a proportion of GDP and per capita are summarised in Table E7 and Figures E5 and E6 below – for the lower estimate[20] and based on benefits given in purchasing price parities (PPP). The results show the benefits vary significantly between the countries, ranging from 36 to 273 EUR per capita in Bulgaria to 232 to 702 EUR per capita in the Czech Republic.

[20] The report tends to present the low results in the summary discussions. If important conclusions can be drawn on the basis of conservative estimates then the implications of a higher estimate is clear.

The range of values across countries reflect several factors – the difference in the actual benefits, variations in data availability allowing benefits estimation, variations in the meaning of data across the candidate countries, and differences in purchasing price parities across countries. For example, the high result in the Czech Republic is strongly influenced by the significant benefits from improvements in river water quality[21]. At the other extreme, the per capita benefits in Bulgaria are relatively small. This is significantly influenced by the far lower PPP ratio for Bulgaria than for example in the Czech Republic or Slovenia. It is important to see the per capita values primarily in the context of national incomes[22].

Benefits as a share of GDP: In terms of GDP, the benefits represent between 0,7% of GDP in Malta and 0,75% in Cyprus to 4,8% of GDP in the Czech Republic. These values indicate the size of the benefits as a proportion of GDP but do not suggest that GDP would rise by a given amount as a result of EU directives[23]. Notwithstanding these variations, the benefits from EU directives are significant for all candidate countries.

It is important to reiterate the fact that these figures correspond to the analysis using the accepted approach of applying PPP weighting factors. The benefits in term of a % of GDP would be significantly higher has no weighting factor been applied. These results should be seen within the methodology context as presented in Parts B on Air, C on Water and D on Waste.

Furthermore, the calculation stems from a comparison of the benefits with respect to today's GDP. Clearly the full benefits will accrue with full implementation (taken here to be 2010), by which time GDP will be larger and this would suggest that the benefits per GDP ratio should therefore be smaller than presented here. However, with economic growth, the willingness to pay is also likely to increase and therefore increase the scale of the benefits. In this study we have not tried to calculate the likely GDP growth rates and the implications on the scale of benefits and hence the linkage to benefits/GDP ratios. It is clear that as GDP goes up, benefits would go up, and the benefits per unit GDP ratio would not necessarily change significantly.

Notwithstanding these variations, the benefits from EU directives are significant for all candidate countries.

[21] This in part reflects the length or rivers in the Czech Republic, but also reflects the national system of classification, which might lead to a slightly different classification than in other candidate countries, influencing the Czech result.

[22] For comparisons across countries it is important to keep in mind the role of the PPP inflators. While additional analysis was carried out without weighting for PPP, the results were significantly higher than without the inflators. These results start to make less sense within a national context (basically one would be attributing unrealistic willingness to pay assumptions), despite having the benefit of easier comparison across countries.

[23] There is one main reason for this. The primary reason is that GDP is an indicator of value added to the economy as given by market values, and not all issues we value are represented by GDP – this includes health, long life, appreciation for clean water. In short, GDP is only intended to be an economic indicator, not a full welfare indicator.

Figure A.8 - Per Capita Annual Benefits from Full Compliance: Lower Estimate

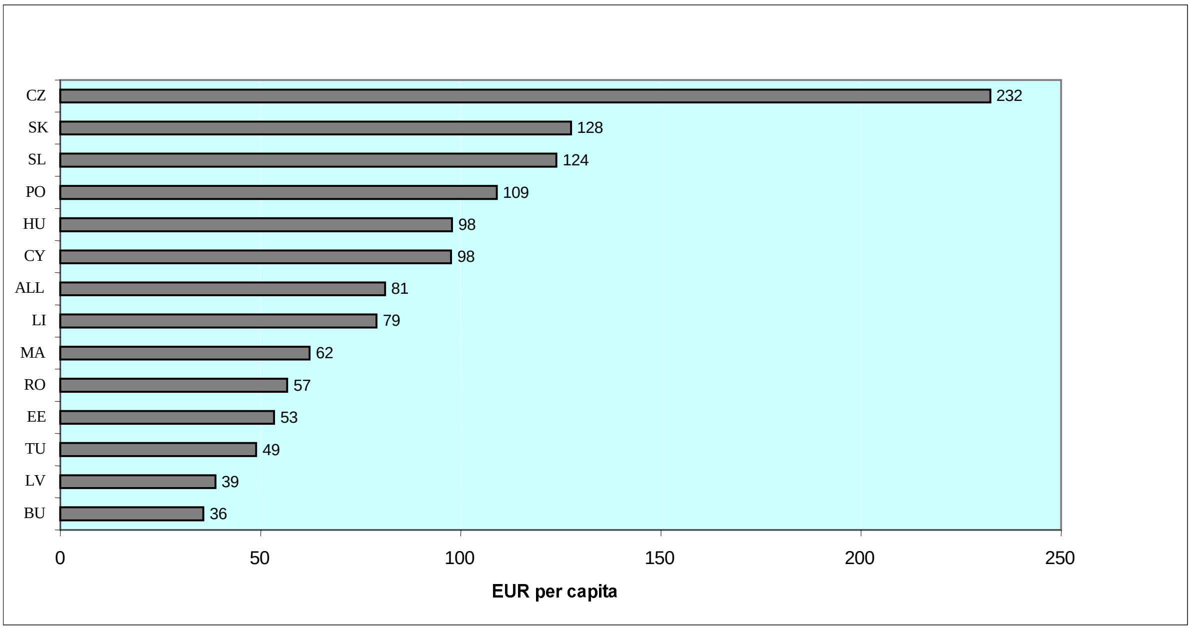


Figure A9 - Annual Benefits of Full Compliance as % of GDP: Lower estimate

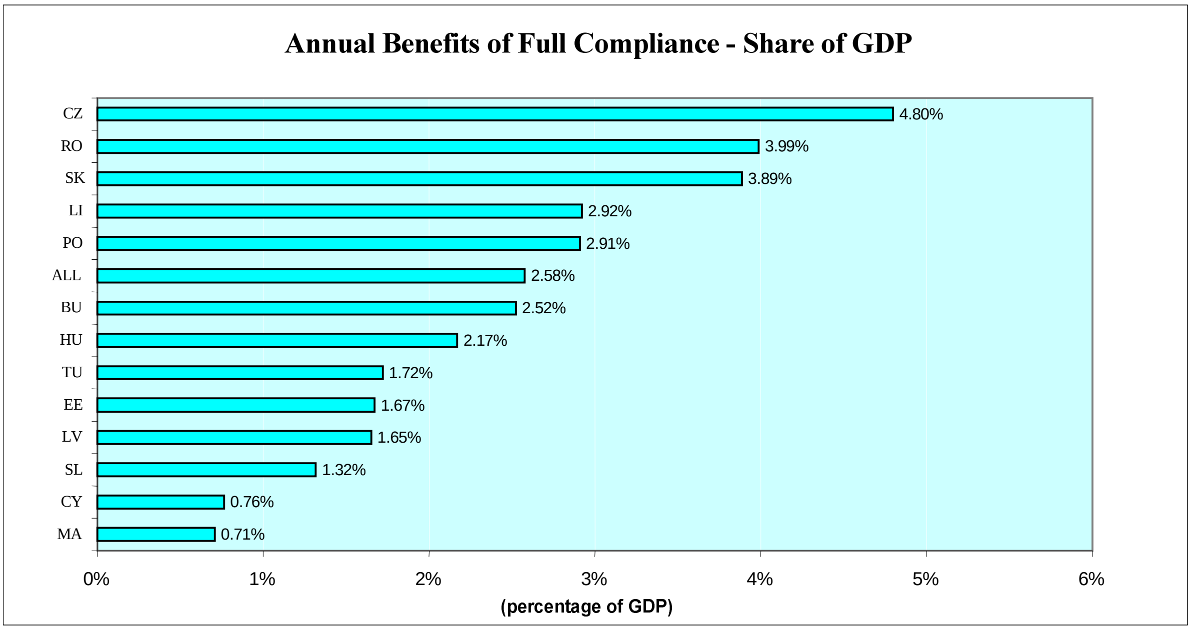


Table A14: Annual Benefits of Full Compliance
By Candidate Country per Capita & as Percentage of GDP

candidate countries	***Ratios of Annual Benefits of Full Compliance***			
	Benefits Per Capita (EUR)		Benefits as % of GDP	
	Low	High	Low	High
Bulgaria	36	273	2,5%	19,3%
Cyprus	98	471	0,8%	3,7%
Czech Republic	232	702	4,8%	14,5%
Estonia	53	340	1,7%	10,7%
Hungary	98	703	2,2%	15,6%
Latvia	39	233	1,7%	10,0%
Lithuania	79	353	2,9%	13,1%
Malta	62	329	0,7%	3,7%
Poland	109	553	2,9%	14,8%
Romania	57	436	4,0%	30,7%
Slovakia	128	624	3,9%	19,0%
Slovenia	124	563	1,3%	6,0%
Turkey	49	233	1,7%	8,2%
Total	**81**	**412**	**2,6%**	**13,1%**

Note: These values are based on benefits values that have been weighted according to the relative per capita PPPs, and therefore reflect the economic situation in the candidate countries. EU average income values have been used as a sensitivity, but are not presented here.

Note: It would be misleading to present a single central estimate as this would implicitly suggest a very accurate knowledge of the relationship between pollutant, impact and monetary benefit. Hence, the lower and upper bounds reflect the bounds of confidence in the results given methodological uncertainties.

The analysis indicates that over half of the subset of benefits that have been estimated in monetary terms is related to the benefits of reduced air (including industrial) pollution. However, it is the case that the benefits from water and waste directives are less exhaustively captured by the monetary analysis, and that the benefits from nature protection are absent. Moreover, in terms of non-environmental benefits, compliance with non-air directives, especially waste related, are likely to be higher because of the commercial opportunities provided by, and the labour intensity of, the compliance programmes.

Total benefits over the period until 2020

The overall benefits for the candidate countries, over the period 1999-2020, from implementing EU directives amounts to between 134 and 681 billion EUR assuming full implementation is achieved in 2010 (see Table E15).

Table A15: Total Benefits over the Benefit Period (until 2020), by Media, by Candidate Country
(Net Present value, assuming: 2010 full Implementation Period, 4% Discount Rate) (Million EUR)

	Present Value (million EUR)							
	Air		**Water**		**Waste**		**Total**	
	Low	High	Low	High	Low	High	Low	High
Bulgaria	1070	11000	1580	4200	195	6620	2850	21800
Cyprus	290	1400	260	960	75	730	630	3050
Czech Republic	7100	35050	15230	24050	925	11200	23260	70300
Estonia	390	2050	260	985	95	1750	750	4780
Hungary	5740	39920	2720	10490	1120	18500	9590	68900
Latvia	485	3120	380	1340	50	1070	915	5500
Lithuania	1555	7980	1230	2750	55	2000	2840	12750
Malta	75	390	125	460	30	390	230	1250
Poland	25800	149930	13590	31960	1600	26300	41000	208200
Romania	7590	56950	3960	12150	825	26300	12380	95400
Slovakia	3400	21900	3000	6610	290	4280	6700	32800
Slovenia	680	4620	1470	3440	240	2820	2400	10900
Turkey	21220	94440	8640	33200	750	18000	30600	145600
Total	75400	428700	52400	132600	6270	112000	134000	681000

Note: Total may not add to sum of the parts given rounding
It would be misleading to present a single central estimate as this would implicitly suggest a very accurate knowledge of the relationship between pollutant, impact and monetary benefit. Hence, the lower and upper bounds reflect the bounds of confidence in the results given methodological uncertainties.

The analysis of benefits using a monetary valuation has been built up from separate estimates of the effects of the air, water and waste related directives. The analysis by these areas (the usual environmental media categories) is provided in more detail in the separately reported Parts of the report. In summary (Table A13 and A15), the analysis indicates that the most significant benefits derive from the effects of compliance on reduced emissions to air, especially from energy and industrial plants and from transport. The benefits from the waste directives, whilst being slightly smaller, have a high level of uncertainty, not just from the actual valuation methodology, but also because there are alternative implementation strategies for securing compliance (essentially between an incineration led strategy and a recycling led strategy, with recycling offering greater benefits, as well as greater economic stimulus).

This analysis, by bundles of directives in the case of air and water, and by selected directives for waste, allows an initial and very crude approximation to the relative importance of individual directives which make up the acquis. However, for the reasons given in Chapter 3.0, we do not consider it appropriate to apportion the benefits specifically to individual directives.

The detailed analysis is given in the remainder of the report. However, to assist in understanding and summarising the benefits for use in subsequent analyses, we have pulled together the key results for each of the candidate countries. This is presented in Annex 1. following the summary concluding remarks.

Sensitivity analysis: Sensitivity analysis has been carried out – not just presenting the upper and lower ranges noted above, but also exploring the role of different implementation time periods (2005 and 2020) as well as the effect of different discount rates. The results of this analysis is not presented here in the executive summary as it offers no valuable additional information above the main (expected) conclusions:

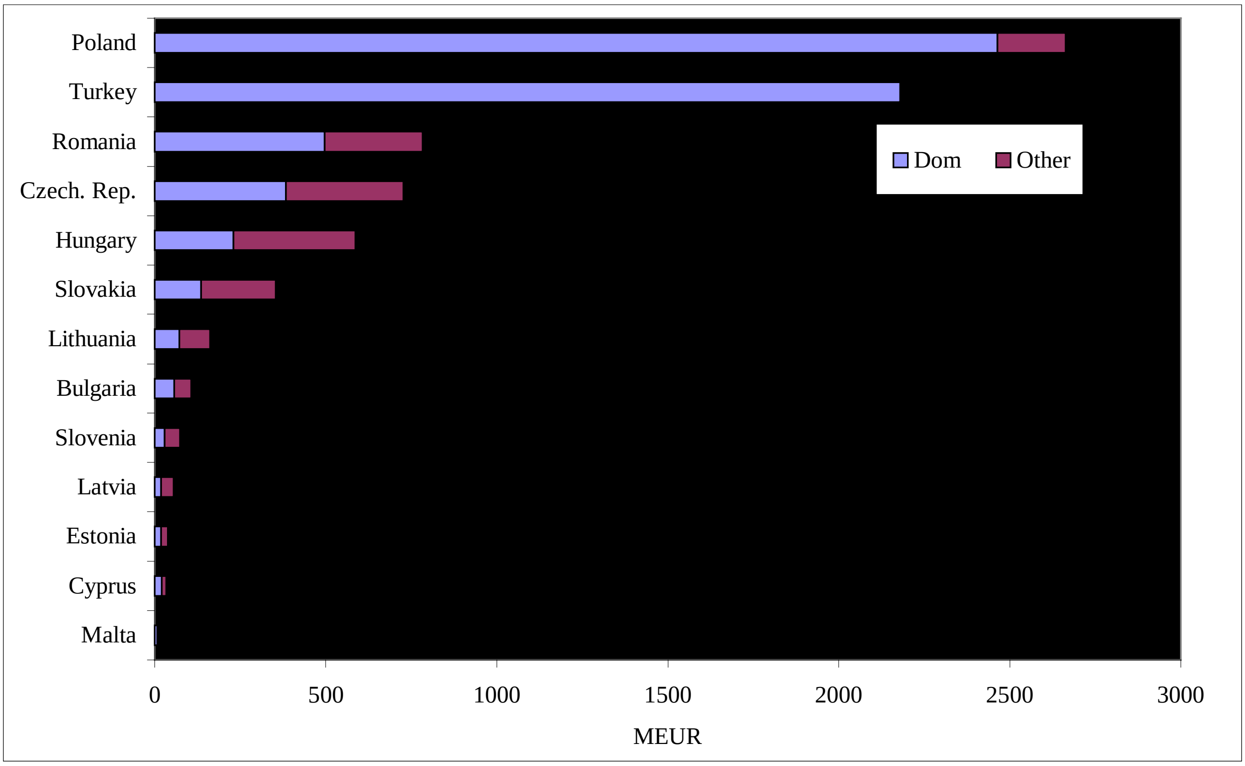
- A lower discount rate would lead to a higher total benefits is in the main report. And as a corollary, the total benefit value would be lower with a higher discount rate. This is because, with a higher discount rate, benefits in the future are regarded as being worth less in today's terms.
- The total benefits will increase with early implementation of the acquis communautaire, as the benefits start to accrue earlier and therefore available over a longer period of time (people benefit from clean drinking water for longer). Again, the corollary is clear: a slower implementation would decrease the benefits.

4.3.3 Air

The benefits from reduced mortality, incidence of diseases, damages to building and crops arising from the full implementation of EU directives are estimated to be worth between 8 and 44 billion EUR in 2010 for the candidate countries.

When taken over the period 1999-2020, the benefits from improved air quality amount to some 75 to 430 billion EUR in net present value terms (Table A15). Poland accounts for about one third of these benefits. There, avoided costs are expected to amount to between 2,7 and 15,5 billion EUR in the year 2010. Figure A10 presents an overview.

Figure A10: Total Candidate Country Benefits – Benefits from Domestic Action and Benefits from action by other Candidate Countries *(MEUR/year upon full compliance in 2010)*



Note: Benefits to Turkey from other country action have been explicitly included given the large uncertainty in the estimate.

Cross border issues

The benefits discussed so far focused on the benefits to the candidate countries. The benefits estimate also offers insights into the relation of benefits in each candidate countries and the actions of all candidate countries, and furthermore the benefits to the EU and third countries from candidate county actions to implement the air related acquis communautaire. Some examples of these transboundary effects are given below:

- Benefits for the candidate countries resulting from reduced air pollution from other candidate countries through their implementation of EU directives amount to 1,7 billion EUR annually, according to the low estimate[24] (see Figure above).
- Some candidate countries benefit significantly from the actions of other candidate countries to implement the acquis. In Hungary, for example, half of the total benefits result from action by other candidate countries.
- As a corollary to the last point, domestic actions can lead to very significant benefits to neighbouring countries. In some cases, foreign benefits are several times larger than the domestic benefits from domestic action. For example, Polish initiatives for complying with EU air directives will lead to between 2,5 and 11,8 billion EUR in benefits for Poland but between 4,1 and 24 billion EUR in benefits to other countries combined.

[24] Turkey not included.

- The EU would benefit significantly from lower emissions of air pollutants from the candidate countries and their implementation of EU directives. This would amount to 6,5 billion EUR annually according to the low estimate. As an example, the EU benefits between 1.7 to 10 billion EUR per year from Polish compliance with EU air directives.
- The total benefits accruing to non-EU third countries (notably Ukraine, Belarus and Russia) from actions by the candidate countries to meet the requirements of EU directives would stand at 9.5 billion EUR per year, again applying the low estimate.

These figures underline the benefits for the whole of Europe from the accession of the candidate countries to the EU and their implementation of EU environmental directives.

Role of specific pollutants

The benefits arise primarily from lower emissions of particulates, the acidic pollutants SO2 and NOx, volatile organic compounds (VOCs) and ammonia (NH3). The reductions in these five pollutants account for over 95% of the value of total benefits for the lower estimate. Reductions in carbon monoxide (CO) and carbon dioxide (CO2) account for a very small fraction of the total benefits[25]. It should be noted, however, that the very low values for CO are a consequence of the lack of clear data of its impact on health. However, these are increasingly recognised to be significant and the benefits are therefore likely to be underestimated. For CO_2, there is similarly a growing awareness of the possible extent of these impacts, but also a lack of data. The importance of these two pollutants is therefore expected to grow in future studies. Other pollutants not assessed here, but which are known to be important, include: ozone in urban areas and dioxin emissions.

Role of Specific Directives

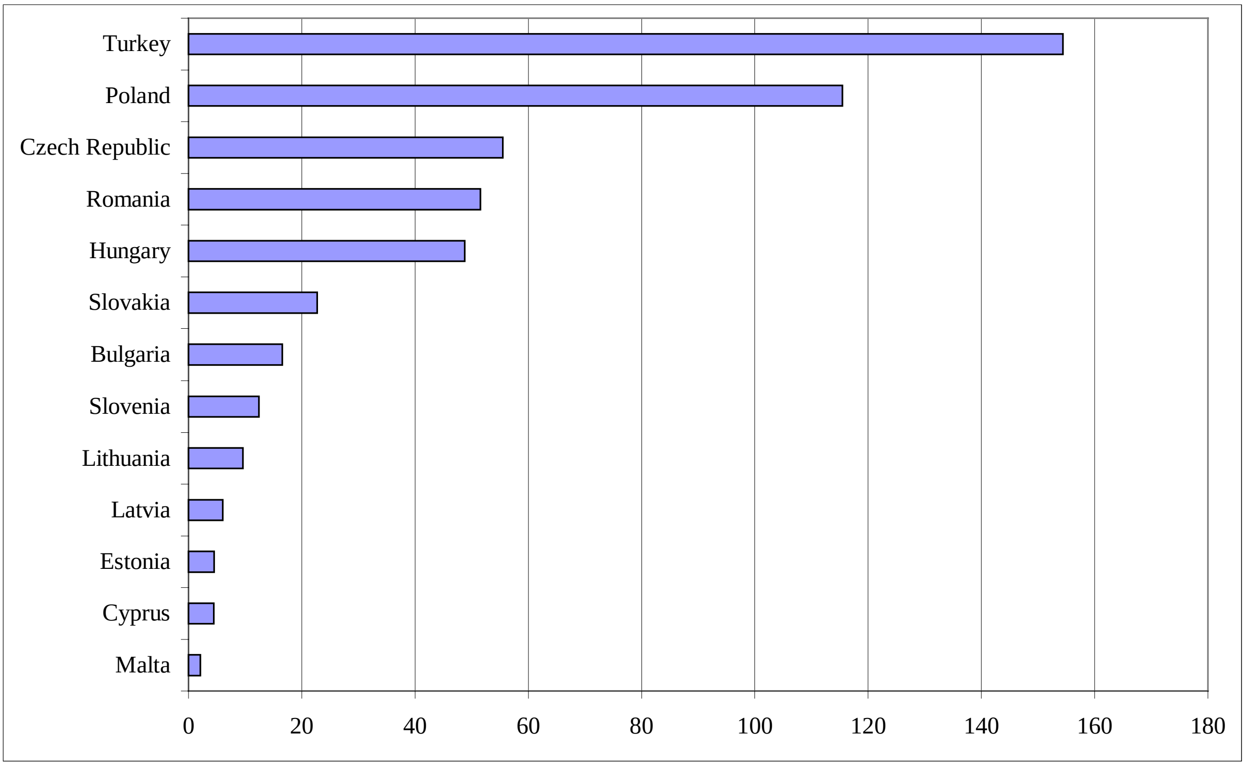
For the air sector, the benefits from different directives cannot be separated sensibly, given the inter-linkages of the directives, and hence this chapter of the environmental acquis has been dealt with as a “bundle of directives”. For example, it is clear that the LCPD, IPPC directive, the Air Framework Directive and daughters and the fuel quality directives all contribute significantly to reductions in SO2 and NOx emissions.

4.3.4 Water

The benefits of implementing the water related acquis were assessed directly for drinking water, for bathing and other surface water quality, and for improved river quality. To be able to implement the associated quality directives required the implementation of upstream directives, notably the Urban Waste water treatment directive, the nitrates directive, the discharge of dangerous substances directive and the IPPC Directive. The final value therefore implicitly includes some aspects of the upstream directives.

[25] The benefits from CO2 are larger as a share of the total benefits under the upper estimate, given that the range of benefits for CO2 is wider than for other pollutants given the greater scientific uncertainty as to the impacts and their costs of global warming.

Figure A11: Benefits of Access to Clean Drinking Water: Lower WTP Estimate *(MEUR/yr upon full compliance)*



Drinking Water

Cleaner drinking water resulting from EU water directives has an estimated value of 500 million to 8,7 billion EUR a year upon full implementation. This is based on the overall demand for clean drinking water. The demand in Turkey accounts for around a third of the total value (150 to 2.650 million EUR a year). Given the assumptions behind the lower and upper estimates (See Part C), it is likely that the upper estimate is more representative of the true benefits than the lower.

Bathing and other surface water quality

The benefits from a better quality of bathing water are estimated at around 2,5 billion EUR a year. Similarly, this is based on the demand for clean bathing water.

Improved river quality

The willingness to pay for an improvement of river quality from ‘poor’ to ‘fair’ and from ‘fair’ to ‘good’ is estimated at 2 billion EUR a year across the candidate countries. This estimate excludes the benefits from direct use, for instance for recreation; this ensures there is no double counting with the above estimates for bathing and surface water benefits. The Czech Republic accounts for more than half of this sum, or 1.2 billion EUR a year. The importance of the Czech figure relates to the fact that data has not been available for an estimate for some countries (hence the high share of the Czech Republic), and secondly the combination of the length of rivers (the CR has the greatest length of rivers among the candidate countries), relatively high PPP, expected river quality improvements and the river quality classification system lead to the particularly high value in the Czech Republic.

Total Value of Benefits

The total value of the benefits from implementing EU water directives across the candidate countries lies in the range of 5 to 14 billion EUR a year (lower and upper estimates respectively). As noted above, the study team feels that the higher estimate is actually more representative of the real benefits than the lower estimate. A summary is presented in Figures A12 (lower estimate) and Figure A13 (higher estimate), with details presented in Part C.

Figure A12: Annual Benefits of Full Compliance with Water Directives: Lower Estimate

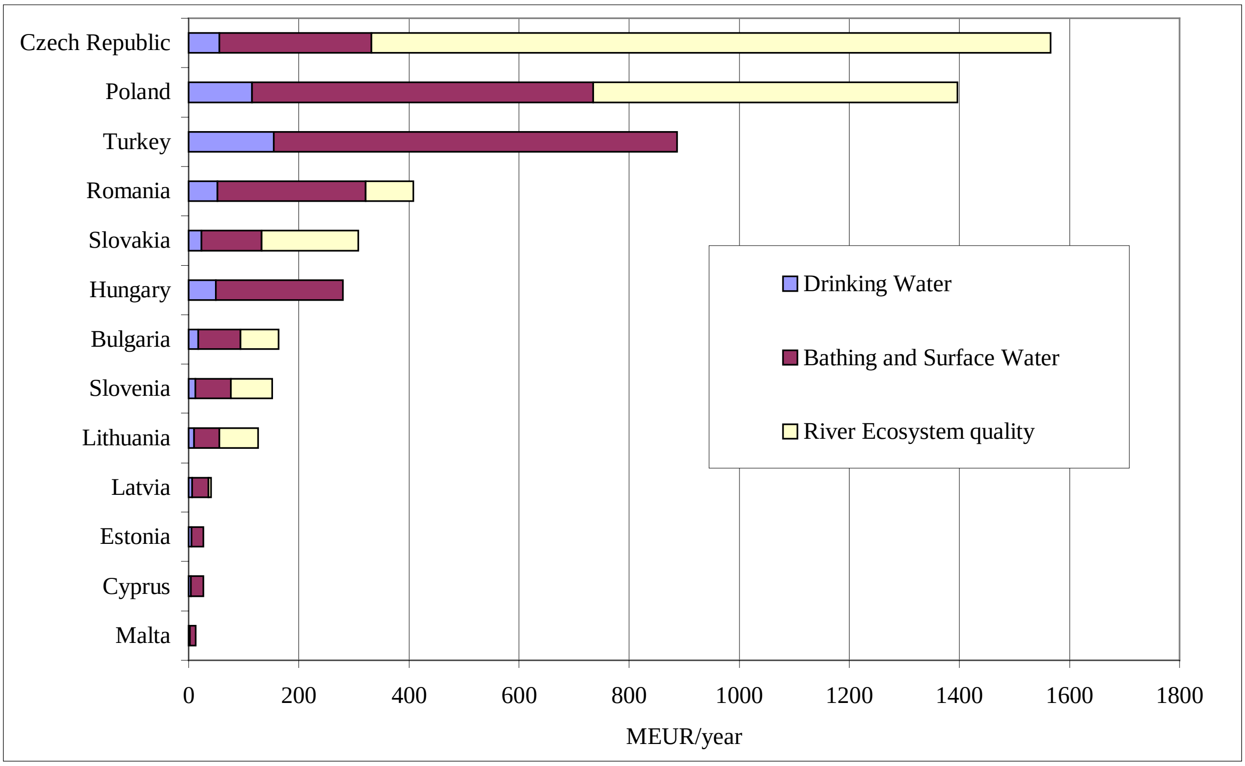
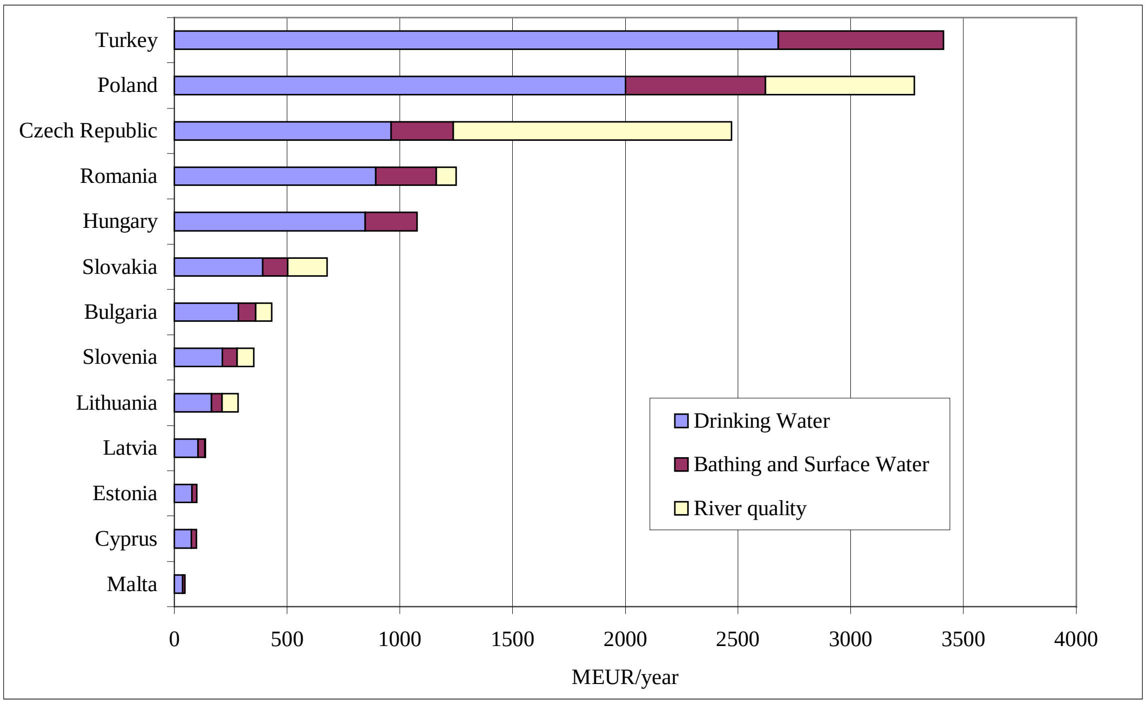


Figure A13: Annual Benefits of Full Compliance: Upper Estimate



4.3.5 Waste

The value of the benefits from EU waste directives (Directives on Landfill and Packaging Waste) have been estimated for all candidate countries. This is based on two scenarios, one with a maximum level of recycling and the other with a maximum level of incineration, giving benefits with a lower and a higher bound for each scenario.

The total annual benefits from full compliance with the Landfill and Packaging Directives were estimated to be higher under the scenario with a maximum level of recycling. In this case, they range from 1,3 to 12,3 billion EUR a year. Under the scenario with maximum incineration, the benefits stand at some 0,6 to 8,7 billion EUR a year. Across all scenarios, benefits from EU waste directives range at 0,6 to 12,3 billion EUR a year. The implementation of the Landfill Directive contributes with the largest share of these benefits.

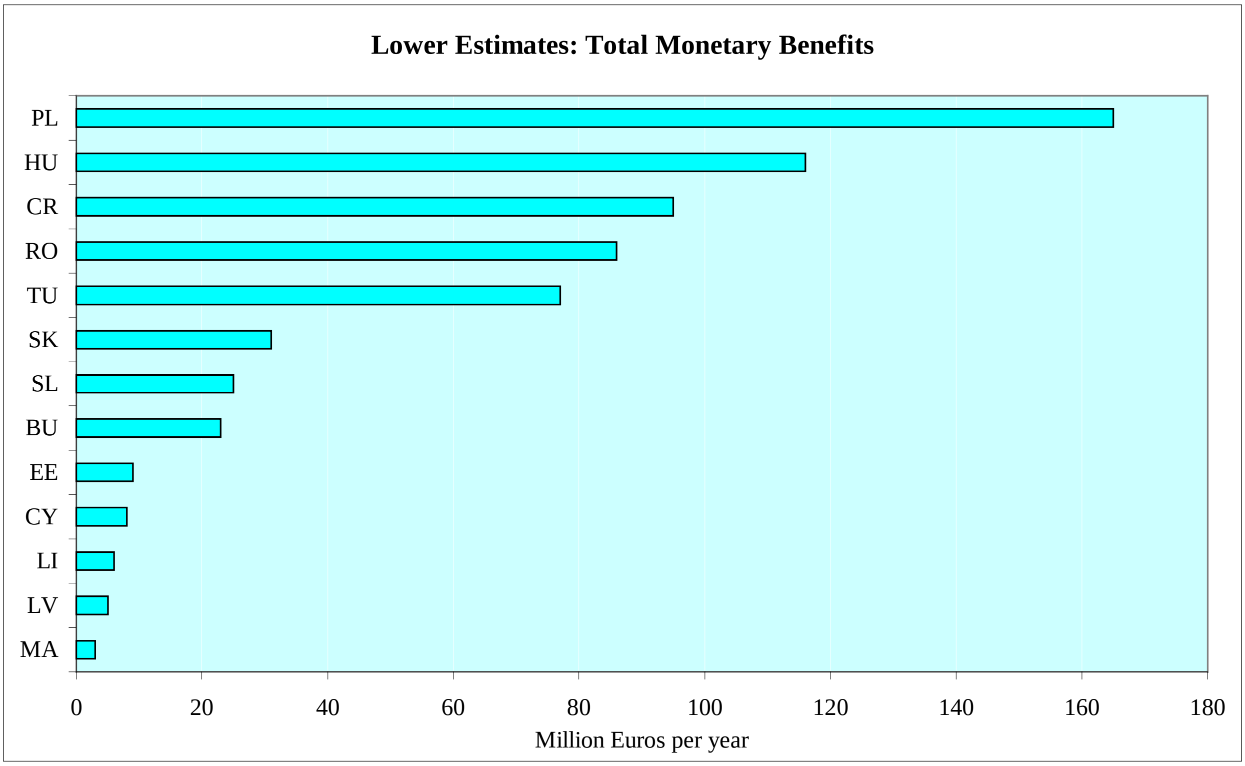
Landfill Directive: For all of the candidate countries, complying with the Landfill Directive by adopting a maximum level of recycling should lead to larger benefits than maximising incineration. Benefits for all countries amount to between 1,1 and 10,9 billion EUR a year for the recycling scenario against 0,4 to 7,3 billion EUR a year for incineration. In reality, the candidate countries are likely to adopt some sort of middle ground between the two extreme scenarios of maximum recycling and maximum incineration. At country level, the highest annual benefits accrue to Hungary (0,15 to 1,7 billion EUR), Poland (0,25 to 2,5 billion EUR) and Romania (0,2 to 2,6 billion EUR).

Packaging Directive: Total benefits from the Packaging Directive range from 156 to 910 million EUR a year for all candidate countries taken together. This relates to the benefits from avoided environmental damage by using secondary materials (e.g. recycled paper, aluminium and glass) instead of more primary materials. The largest annual benefits are experienced by Hungary (10-107 million EUR), Poland (35-191 Million EUR) and the Czech Republic (22-148 million EUR).

Incineration Directive (Czech Republic only): Incineration gives lower benefits. This is clearly illustrated by the example of the Czech Republic for which benefits from complying with the EU incineration directives ranges from 3 to 22 million EUR a year. This is only around 13% of the Czech Republic's benefits from the Packaging Directive.

The total benefits for the implementation of the waste directives are depicted in Figure A13 – for the lower estimate. Recall Table A.13 and see Part D for further details.

Figure A13 Total Annual Monetised Benefits from Compliance with Waste Directives: Lower Estimates *(in MEUR per year upon full compliance).*



4.4 Interpretation of Results

The authors do not pretend that the monetary estimate for the benefits is the final measure of benefits. The monetary benefits analysis is therefore focused on that audience that will be able to use the monetary analysis to gain a deeper appreciation of the scale of the benefits likely to accrue from implementing the national legislation compliant with the EU acquis communautaire. To reiterate, it is also important to remember that the monetary assessment covers only a subset of directives and benefits from directives and that the monetary analysis should therefore be seen side by side with the qualitative analysis that presents the broader picture with more of the benefits.

4.4.1 Types of Benefits

The estimate of total benefits is based on an analysis of the changes in pollution attributable to compliance with the Directives and the effects on ‘receptors’ (e.g. health of people, the amenity value of the environment, the repair of buildings and the productivity of natural resources). These damage cost savings are therefore built up from the benefits from given unit reductions in specified pollutants, or from the assumed willingness to pay (WTP) of people for specified improvements in health, recreation and amenity value.

The analysis indicates that for the subset of benefits that can be measured in monetary terms, over 80% of the benefits relate to the improved health of people resulting from reduced pollution (especially of air pollutants). The measurement of health benefits needs to be understood in the context of the continuing debates about how to value the benefits from the changes in risks to life expectancy, and whether such values should reflect national income (as mentioned above in footnote 11). The lower estimates of benefits takes a conservative view (in terms of the scale of benefits) of both of these issues – in the former case looking at the lower bounds of risk/impacts and in the latter, using national purchasing power indicators.

The benefits from full compliance also comprise non-monetary benefits, especially the protection of sensitive ecosystems and biodiversity, and non-environmental benefits, especially the boost to economic activity from the related construction and operation of environmental infrastructure required by compliance programmes. In the case of nature conservation, full compliance with provisions would secure protection of many thousand hectares of valuable habitats and hundreds of endangered species from the threats of social and economic activity, much of which is expected to grow as a consequence of accession. Economic benefits include the generation of major new employment opportunities and increased economic efficiency.

4.4.2 The relative importance of different media

A simplistic focus on the final benefits results presented in monetary terms would suggest that the benefits from the implementation are significant lower than from the water directives, which in turn are lower than the benefits from the implementation of the air related directives. Such a conclusion would be erroneous and unhelpful. As stated earlier, the coverage of issues that can be monetised varies significantly across directives and media. Existing scientific literature is more advanced on the analysis of air pollution impacts than on the analysis of water-based impacts, which in turn is more advanced than the science on waste related impacts. It is clear that the waste numbers significantly underestimate to the total benefits (See Part D for further discussion). It is therefore doubly important that any interest in the benefits from the implementation of the acquis communautaire focus equally on the qualitative assessment (see chapters 1 in the Part B on Air, Part C on Water, Part D on Waste and Part E on Nature), as on the quantitative assessment or the monetary analysis, and to see the quantitative and monetary estimates in the appropriate context of what they have been able to cover given scientific knowledge and data availability.

4.4.3 The Relative Contribution to Benefits of Different Directives

The purpose of the analysis is not only to understand the overall benefits associated with implementing the acquis, but also to understand, to the extent possible, the role of particular directives[26] in leading to these benefits. In the case of Directives related to waste management, a Directive specific approach has been able to have been taken, but not all the relevant waste Directives have been assessed. In the case of air pollution, the reduction in specified pollutants will be determined by the joint influence of a number of the Directives, and hence their benefits have been assessed as a "bundle of Directives" In the case of water, only benefits at an aggregate level have been defined – for example where benefits of improvements of water quality can be assessed, but a number of different directives (both down stream quality directives and upstream emissions related directives) contribute to the quality. It is therefore extremely difficult to attribute shares of the estimated benefits to individual Directives. Some disaggregation has been possible (see Part C), but several directives lead to the benefits.

Even if it were possible, there is strong case for suggesting that such a breakdown is unnecessary. This is because of the inter-relation between the different directives of the environmental acquis – the implementation of down-stream quality standard related directives would only lead to full benefits if upstream directives are implemented in parallel. For examples, the bathing waters directive cannot sensibly be implemented without also implementing the Discharge of Dangerous Substances to the aquatic environment directive and the Urban Waste Water Treatment Directive. Furthermore, many investment projects address more than one directive at once, and in some cases it makes little sense to have directive specific projects.

If the political process requires such a breakdown of benefits, one could point to the fact that over half of the subset of benefits measured in monetary terms derive from reductions in air pollution (including industrial pollution control). However, it is the case that the benefits from water and waste Directives are less exhaustively captured by the monetary analysis, and

[26] The analysis has not sought to assess the benefits resulting from a specific requirement of a directive, nor assess the marginal benefits that accrue as the directive is increasingly implemented (e.g. for the different agglomeration size targets for the Urban Waste Water Treatment Directive, or the staged targets to reduce waste to landfill in (Article 5 of) the Landfill directive. Instead, we have focused on assessing the aggregate benefits and not reopening a debate on which bits of the Directive are most valuable.

that the benefits from nature protection are absent entirely. Moreover, in terms of non-environmental benefits, compliance with non-air directives, especially waste related, are likely to be higher because of the commercial opportunities provided by, and the labour intensity of, the compliance programmes.

Attribution of benefits might be helpful if some of the investment heavy directives were considered to provide only limited contribution to the benefits. However, it is extremely difficult to argue, given the nature of the benefits, that this is the case. Rather it argues for a focus on designing the most cost-effective *integrated* programme of compliance, at least across a sector (air, water, waste, nature etc). The analysis in this study provides a major starting point for this work.

5.0 CONCLUSIONS SUMMARY

5.1 Key Conclusions

This study has highlighted and assessed the range of benefits that the implementation of EU environmental directives will bring to the candidate countries. The key results show that:

- ***Avoided illness and mortality:*** There are very significant benefits to be gained by all candidate countries from fully implementing EU directives. For example, fully implementing the EU directives related to air quality can lead to between 15.000 and 34.000 fewer cases of premature deaths from exposure to air pollution, and between 43.000 and 180.000 fewer cases of chronic bronchitis.
- ***Total monetary benefits:*** When taken all together, the annual value of these benefits ranges between 12 and 69 billion EUR. This corresponds to between 80 and 410 EUR per capita. Over the time period until 2020, the cumulative benefits amount to between 134 and 681 billion EUR. Given all uncertainties with these figures, it is important, to take the lower figure in this range as the main result of the study. Even when the lower figure is used, the study clearly suggests that the value of benefits is significant and that the importance of the benefits could usefully be explored in more detail for key decisions in the candidate countries.
- ***Benefits - Air:*** Improved air quality, resulting from the implementation of EU directives, accounts for around 55% of the total value of these benefits. The benefits from reducing air pollution relate mainly to improved public health through fewer respiratory diseases and, most importantly, fewer cases of premature deaths. There are also significant benefits from a reduced burden on agricultural crops and avoided damages to buildings.
- The benefits of EU directives do not only accrue to the candidate countries. Reductions in trans-boundary air pollution will yield significant cross-border and trans-national benefits. The main results are:[27]
    - Benefits from domestic actions amount to around 6 billion EUR. Domestic benefits from actions by other candidate country add a further 1.7 billion EUR.[28]
    - Total benefits from actions by the candidate country for other countries amount to 16 billion EUR a year. The EU Member States benefit 6.5 billion EUR and other countries, notably the Ukraine, Belarus and Russia, some 9.5 billion EUR a year.
    - Overall the benefits of candidate country implementation of the acquis will lead to as many benefits outside the candidate countries as within the candidate countries.
- ***Benefits - Water:*** The benefits from implementing the EU's water related directives include improved access to clean drinking water, bathing water and rivers. Up to 59 million households could benefit from improved drinking water quality, and 10 million households are expected to benefit from new connection to drinking water. River quality

[27] All applying the lower estimate of benefits.
[28] Turkey not included.

will improve, for example with the number of “good” quality rivers more than doubling in Bulgaria. The value of these benefits, together with benefits of increased recreation from cleaner surface waters, amount to around 5 to 14 billion EUR a year.

- ***Benefits – waste:*** The benefits from implementing EU waste directives include reduced methane emissions, which benefit public health and global warming and a reduced impact on the environment through increased recycling and the lower use of primary materials. The level of recycling is likely to increase by around 3,7 million tonnes from the implementation of the Packaging Directive– or on average around 22 kg per capita. In addition, in spite of an estimated 2% growth in waste generation, the Landfill Directive is calculated to lead to a reduction of waste disposed in landfills from around 59 million tonnes in 1998 to between 20 and 35 million tonnes in 2020; implementing the Landfill Directive (under the maximum recycling and composting scenario) will lead to around 54 million tonnes of diverted bio-degradable waste being recycled or composted by 2020. The reduction in methane emissions should be between 1 and 6 million tonnes per year. The value of the waste related benefits ranges from 1 to 12 billion EUR a year, with the benefits likely to be higher under the maximum recycling scenario than under the incineration scenario.
- ***Benefits – nature:*** In the case of nature conservation, EU directives would secure protection of many thousand hectares of valuable habitats and hundreds of endangered species, especially endemic species.
- ***Employment benefits:*** In addition, the expenditure on environmental goods and services will help develop the eco-industry sector of the economies and support significant jobs within this sector. The order of magnitude estimate derived here suggest that up to 1.8 million jobs could be supported at any given time, of which around 0.5 million would stem from capital expenditure and the remaining 1.3 million from the provision of environmental services and from the operation and maintenance of environmental infrastructure. These values are “gross jobs” and no estimate has been made of the total number of “net jobs”.

In addition, many benefits of EU directives have not been fully covered when assessing the monetary values. This includes the protection of sensitive ecosystems and bio-diversity. Some environmental investments might also lead to benefits not directly related to the environment. They can improve economic efficiency and boost productivity, for example by facilitating the take-up of modern technology, by lowering production and maintenance costs for companies through better water quality and by providing savings in the form of more efficient waste management.

From this range of benefits, three key conclusions can be drawn:

- Implementing the EU environmental directives can help ***improve the health and quality of life for citizens*** across the candidate countries, and to a certain extent, for citizens of the EU.
- ***Co-operation across candidate countries*** is crucial to maximise the transboundary benefits from reducing air pollution.

- In narrow monetary terms, the assessed ***benefits are likely to be of the same order of magnitude if not larger than the costs*** of implementing EU directives. However, this result should be treated with caution as there is considerable uncertainty for estimates both of benefits and costs.

5.2 Interpretation of results

The study does not suggest that the money value for the benefits of EU directives is the final measure of these benefits. Nor do the authors mean to imply that these benefits can really be equated to money, but rather it is an indicator of importance of the benefits. There are significant ethical and methodological concerns that should be taken into account.

The ethical concern is clear: Some object as a matter of principle to giving illness, life and damage to eco-systems an economic value. A general response is that people naturally make trade-offs between the environment and their economies. The aim of the monetary value is to identify the choice that people (and government & industry) want, and to demonstrate that there are real benefits to be had from implementing EU directives in the candidate countries.

The methodological concern is also clear: only some benefits have been taken into account; there are data limitations, difficulties in assessing future economic growth and increasing environmental pressures, and also limitations of the methods used. This underlines the fact that:

- For the monetary analysis, no single figure can be given, and that broad ranges are needed for an honest analysis. However, the meaning of the range can be taken seriously, although the reader should be aware that the true value might be outside the range given here.
- The monetary analysis needs to be seen side by side with the qualitative analysis, which presents insights on a wider range of benefit than could be taken into account in the monetary analysis. The monetary analysis should not be seen as the only end point of the study.

The study has drawn upon the latest scientific literature, evaluation models, scientific literature, and the latest available data from across the candidate countries and evidence from wider afield on the benefits of implementing the acquis. This would therefore suggest that in the foreseeable future it is unlikely that a more comprehensive analysis of benefits would be available for the breadth of coverage of countries and directives (see F4 for possible next steps). While every effort has been made to recognise and take account of uncertainties, these do not diminish the clear evidence that indicates that there are major environmental and economic benefits from the implementation of the environmental acquis communautaire by the candidate countries.

5.3 Policy Recommendations

The results and discussion above have a number of implications for the environmental policy of the candidate countries in the context of their accession to the EU.

i) The benefits assessment suggests that there could be significant benefits from EU environmental directives that have not always been fully taken into account when taking decisions on transposing and implementing these directives. The scale of the benefits suggests that this aspect should be integrated into decisions on implementation planning. This may lead to the conclusion that the candidate countries' current efforts for implementing EU environmental directives should be maintained, if not strengthened.

ii) The total benefits resulting from EU directives are higher if their implementation is accelerated. This is because the benefits would start to accrue earlier given earlier reductions in emissions, improvements in air and water quality and waste management practices. Clearly an accelerated investment programme would also lead to the costs of compliance being higher[29]. However, the increase in benefits would be larger than the increase in compliance costs under an accelerated compliance programme.

iii) The benefits are not confined to specific elements of the environmental legislation, the full set of directives is important in generating benefits. The inter-relations between directives are strong and the implementation of several of them is needed to ensure full benefits. The implementation plans could valuably reflect this by ensuring that all directives are looked at and that the dangers of prioritising only a small subset of directives are avoided.

iv) While it is, in principle, possible to do broad cost-benefits analyses of EU directives, the implementation programmes should ensure that they are not only driven by such considerations because this might exclude other equally important issues that are difficult to quantify in monetary terms. This includes, among others, many important social benefits such as bio-diversity. The monetary assessment should be taken as a strong indicator and a tool. However, other types of benefits should also be given due consideration.

v) The environmental benefits will be enhanced if the implementation of other policy areas such as agriculture, transport and energy takes into account environmental concerns and integrates the principle of sustainable development. Similarly, the implementation of the other policy areas could usefully take on board the knowledge of the likely benefits associated with environmental measures.

In short, this analysis, by highlighting, assessing and valuing the benefits of compliance with the body of EU environmental directives has demonstrated the interest to the candidate countries and to the EU of ensuring that the environmental legislation is given the priority it deserves.

[29] Early investment to comply with the acquis will lead to more years of operation and maintenance costs. However, there will be no effective change to the size of investment costs, apart from in net present value terms, given the opportunity cost of money. On the other hand, early compliance will bring about additional years worth of full benefits. The relative increase in benefits will be larger than the increase in the costs, assuming reasonable cost of capital.

5.4 Possible Further Applications of the Benefits Valuation Approach

The study analysis has focused on all thirteen candidate countries and most of the main directives. This has implied that the analysis on any specific country or specific directive has not always been as in-depth as could have been wished. Nevertheless, the study team feel that the study offers a good overview picture of the scale and nature of the benefits that are likely to accrue from the full implementation of the environmental acquis communautaire in the candidate countries. To take such analysis further and to allow for a greater depth, the following could be valuable:

- An in-depth analysis of the benefits to a particular locality – such as a municipality – which could help in the further development local sustainable development action plans;
- A regional approach – focussing on a river basin for example.
- An analysis on a protected area or bathing area of potential tourist value to help clarify the potential opportunities of (eco) tourism which could subsequently create an improved rationale for the safeguard of sensitive areas.
- A media specific or even directive specific focus, though taking into account the inter-linkages to other directives.
- An evaluation of the benefits of investment programmes, whether national or international.
- Benefits valuation linked to new infrastructure and hence use to clarify pricing policy and the timescale of moving towards, where appropriate, full cost recovery systems.
- Incorporation of a broader benefits assessment into EIAs or project selection; and, if carried out during project design will lead to an improved benefits.
- Finally, a benefits assessment could be usefully incorporated into a broader sustainable development assessment, which can help contribute to a move towards a sustainable (development) growth path.

These steps could therefore allow additional insights to be obtained into the benefits of policies, programmes and investments and support the process of ensuring that the greatest benefits can be achieved from the implementation of the acquis communautaire in the candidate countries.

PART A
ANNEX

ANNEX 1: Country Specific Summary

This annex presents the summary overview of the benefits of implementing the acquis in the 13 candidate countries. For further details on the benefits on air, water, waste, nature and socio-economic (focus: employment) benefits, see Parts B to F respectively.

It is important to underline that the aim of the study was to carry out an overall benefits assessment for the implementation of the environmental acquis in the candidate countries and not to do and in-depth analysis of any one particular country. Given the nature of such a broad study, and the variable availability of data, the country coverage is not even. This being said, the study should offer some valuable insights to each candidate country in the many type of benefits of implementing the acquis, some indication of the scale of importance of implementing these, offering some country specific insights, as well as highlighting the value of doing a benefit assessment exercise.

Bulgaria

	Air	Water	Waste	Nature
Qualitative	• Health risks will decrease, especially in the 14 'hot spots' regions and large cities • Industrial installations will be better regulated (IPPC) • Increasing traffic problems will be better managed	• Drinking water: less contamination (esp. microbial) • Black Sea: Improvement of water quality/beaches • Improved river protection (e.g. Danube) • Prevention of groundwater contamination from abandoned mines	• Disposal practices are unsafe, most landfills do not comply with requirements and the capacity for the disposal of hazardous waste is not sufficient. Improvements will lead to a reduction of risks to health and the environment	• Reduced land-use of protected areas and avoided encroachment of human settlements • Many species currently not protected will be protected by the Habitats Directive
Quantitative	• Morbidity impacts (equivalent number of chronic bronchitis cases avoided each year, low estimate): 437	• Before implementation: 23% of rivers of good, 18% of fair, 40% of poor and 11% of bad quality • After implementation: 41% of good and 59% of fair quality	• Estimate of methane emission reduction per year by 2020 in 1000 tonnes (low estimate): 48.740 • Increase in recycling and composting per year by 2020 in tonnes: 3.365.289	• Expected increase in protected areas (until 2020) as a percentage of each country's total surface area: +2.5 percentage points (from 5% to 7.5%)
Monetised	• Total annual benefits of full compliance (low estimate): 130 million Euro/year	• Total annual benefits from full compliance with water related directives (low estimate): 133 million Euro/year	• Total annual benefits of full compliance (low estimate): 20 million Euro/year	

Czech Republic

	Air	Water	Waste	Nature
Qualitative	• Reduced acidification of soils and direct damage to forests (mainly from SO2 and NOx) in the 'Black Triangle' • Improvement of air quality on the local level, esp. in large cities (e.g. Prague) • Cleaner air will help the development of spa areas many of which are in polluted regions	• Improvement of water quality and ecosystem protection for transboundary rivers • Improved quality of soil and water ecosystems • Improved monitoring of drinking water quality	• Benefits (to environment and human health) from improvement in the management of landfill sites and hazardous waste • Higher recycling rates • Upgrading incinerators will decrease health risks, esp. in urban areas	• Benefits can arise from less unfavourable agricultural practices (heavy use of chemicals) and a lower percentage of arable land devoted to agriculture
Quantitative	• Morbidity impacts (equivalent number of chronic bronchitis cases avoided each year, low estimate): 1528	• Before implementation: 10% of rivers of fair, 40% of poor, 40% of bad and 10% of very bad quality • After implementation: 10%of good and 90% of fair quality	• Estimate of methane emission reduction per year by 2020 in 1000 tonnes (low estimate): 42.412 • Increase in recycling and composting per year by 2020 in tonnes: 3.084.848	
Monetised	• Total annual benefits of full compliance (low estimate): 650 million Euro/year	• Total annual benefits from full compliance with water related directives (low estimate): 1.460 million Euro/year	• Total annual benefits of full compliance (low estimate): 95-1,150 million Euro/year	

Cyprus

	Air	Water	Waste	Nature
Qualitative	• Local air quality will improve considerably, particularly in major towns such as Nicosia	• The numerous beaches will benefit from better water quality • The water directives will help protect the scarce water resources	• There will be more and better managed landfill sites, reducing nuisance and pollution • Recycling rate will increase	• Benefits will arise from reduced oil pollution, managed fish farming and more sustainable urbanisation and tourism • Protection of marine ecosystems will be improved
Quantitative	• Morbidity impacts (equivalent number of chronic bronchitis cases avoided each year, low estimate): 99		• Estimate of methane emission reduction per year by 2020 in 1000 tonnes (low estimate): 94 • Increase in recycling and composting per year by 2020 in tonnes: 288.191	
Monetised	• Total annual benefits of full compliance (low estimate): 20 million Euro/year	• Total annual benefits from full compliance with water related directives (low estimate): 6 million Euro/year	• Total annual benefits of full compliance (low estimate): 8 million Euro/year	

Estonia

	Air	Water	Waste	Nature
Qualitative	• Improvement of health in currently heavily polluted areas. esp. in industrial areas in the north-east • Air quality in bigger towns (e.g. Tallinn, Tartu) will be improved • Health benefits will occur in the oil shale regions where power station emissions will be significantly reduced	• Improved bathing water quality attracts tourists • Economic benefits from freshwater sport and commercial fisheries • Drinking water: removal esp. of iron and hydrogen sulphide	• Improvement of the management of landfill sites will bring about health and environmental benefits • Proper disposal of hazardous waste, e.g. from the oil shale industry, will reduce risk to local population	• Benefits can be derived from preventing bog peat harvesting, reduced drainage of forests and mires and better management of infrastructure and tourism
Quantitative	• Morbidity impacts (equivalent number of chronic bronchitis cases avoided each year (low estimate): 170		• Estimate of methane emission reduction per year by 2020 in 1000 tonnes (low estimate): 11.143 • Increase in recycling and composting per year by 2020 in tonnes: 590.618	• Expected increase in protected areas (until 2020) as a percentage of each country's total surface area: +2.3 percentage points (from 16% to 18.3%)
Monetised	• Total annual benefits of full compliance (low estimate): 40 million Euro/year	• Total annual benefits from full compliance with water related directives (low estimate): 110 million Euro/year	• Total annual benefits of full compliance (low estimate): 10 million Euro/year	

Hungary

	Air	Water	Waste	Nature
Qualitative	• Parts of the industry still does not meet BAT standards, approximation will lead to significant local health benefits • Traffic pollution which is a health risk particularly in Budapest will be managed under the vehicle and air framework directives	• Improved protection of rivers (esp. Danube) and bathing waters (esp. Lake Balaton) • Less discharges from domestic and industrial waste water	• Reduction of uncontrolled disposal and better management of existing landfill sites will lead to health benefits and less damage to the environment	• Nature conservation will help prevent excessive hunting, expansion of agriculture and forestry activities • Additional protection for important areas such as Lake Balaton or the Danube bend
Quantitative	• Morbidity impacts (equivalent number of chronic bronchitis cases avoided each year (low estimate): 1589	•	• Estimate of methane emission reduction per year by 2020 in 1000 tonnes (low estimate): 113.035 • Increase in recycling and composting per year by 2020 in tonnes: 3.977.437	• Percentage of threatened mammal species of all mammal species: 11.1%
Monetised	• Total annual benefits of full compliance (low estimate): 580 million Euro/year	• Total annual benefits from full compliance with water related directives (low estimate): 190 million Euro/year	• Total annual benefits of full compliance (low estimate): 115 million Euro/year	

Latvia

	Air	Water	Waste	Nature
Qualitative	• Half of the population of Latvia lives in seven large cities where the main air pollution sources are located. Implementation of the acquis will lead to significant health benefits •	• Improved bathing water quality attracts tourists • Improved waste water treatment (esp. Riga) • Less contamination of groundwater (main drinking water source) • Improved ecosystem management of the Daugava River basin	• Unregular dumping due to a lack in collection services will reduce damage to the environment and human health • Improvement of existing landfill sites will being about benefits to local population	• Benefits from managing over-extraction of forest resources, prevent hunting, more sustainable tourism, measures promoting less intensive farming and management of extension of human settlements and agricultural areas
Quantitative	• Morbidity impacts (equivalent number of chronic bronchitis cases avoided each year (low estimate): 208	• Before implementation: 25% of rivers of good, 36% of fair, 35% of poor and 4% of bad quality • After implementation: 61%of good and 39% of fair quality	• Estimate of methane emission reduction per year by 2020 in 1000 tonnes (low estimate): 6.268 • Increase in recycling and composting per year by 2020 in tonnes: 589.592	• Percentage of threatened mammal species of all mammal species: 4.8%
Monetised	• Total annual benefits of full compliance (low estimate): 180 million Euro/year	• Total annual benefits from full compliance with water related directives (low estimate): 147 million Euro/year	• Total annual benefits of full compliance (low estimate): 5 million Euro/year	

Lithuania

	Air	Water	Waste	Nature
Qualitative	• Cities such as Vilnius and Kaunas will benefit from emissions reduction and traffic management • LPC directive will ensure protection of the environment for developments such as Butinge oil terminal	• Improved opportunities or tourism • Improved protection of the Curonian lagoon ecosystem • Enhanced waste water treatment in rural and urban centres (e.g. Vilnius)	• Most existing landfills are a threat to the environment. • Improvements will reduce risks, e.g. of groundwater contamination	• Better protection will be provided to the important conservation areas of the Curronian Spit and Lagoon, as well as the wetland region on the south • Threats to forests by intensive logging will be reduced
Quantitative	• Morbidity impacts (equivalent number of chronic bronchitis cases avoided each year (low estimate): 1061	•	• Estimate of methane emission reduction per year by 2020 in 1000 tonnes (low estimate): 5.271 • Increase in recycling and composting per year by 2020 in tonnes: 1.343.456	• Expected increase in protected areas (until 2020) as a percentage of each country's total surface area: +8 percentage points (from 11% to 19%)
Monetised	• Total annual benefits of full compliance (low estimate): 50 million Euro/year	• Total annual benefits from full compliance with water related directives (low estimate): 295 million Euro/year	• Total annual benefits of full compliance (low estimate): 6 million Euro/year	

Malta

	Air	Water	Waste	Nature
Qualitative	• Air pollution from power station that do not meet BAT standards (e.g. Marsa) will decrease • Problems of pollution from traffic (e.g. in Valetta) will be reduced	• Improved bathing and drinking water quality, benefits to both the local population and tourism • Major benefits through protection of Malta's single aquifer • Reduction of high nitrate level in groundwater	• Pressure on the environment, health and scarce land resources form uncontrolled landfilling will be reduced • Waste arising will be smaller • Disposal of hazardous waste at mixed landfill sites will be stopped • Health risks from waste incineration will be reduced	• Prevention of bird shooting and trapping • Enhanced protection of marine ecosystems • Threats to habitat destruction (due to high density of population) will be reduced
Quantitative	• Morbidity impacts (equivalent number of chronic bronchitis cases avoided each year (low estimate): 21	•	• Estimate of methane emission reduction per year by 2020 in 1000 tonnes (low estimate): 1.578 • Increase in recycling and composting per year by 2020 in tonnes: 105.130	Expected increase in protected areas (until 2020) as a percentage of each country's total surface area: +10 percentage points (from 18% to 28%)
Monetised	• Total annual benefits of full compliance (low estimate): 4 million Euro/year	• Total annual benefits from full compliance with water related directives (low estimate): 3 million Euro/year	• Total annual benefits of full compliance (low estimate): 3 million Euro/year	

Poland

	Air	Water	Waste	Nature
Qualitative	• Power stations and heavy industry are responsible to poor air quality (through SO2 and NOx) and acidification, esp. around Katowice and the Polish part of the Black Triangle • Better management of traffic emissions, esp. in larger cities such as Warsaw or Krakow	• Improved waste water collection and treatment (esp. in rural areas) • Benefits to drinking water quality • Improved water quality of transboundary rivers and the Baltic Sea	• Proper disposal of hazardous waste will minimise risk to human health • Reduction of fly-tipping will help protect eco-systems	• Benefits will arise from measures to tackle waters and soil pollution, improved forest management, more sustainable development of infrastructure, sustainable exploitation of resources and better protection of biodiversity
Quantitative	• Morbidity impacts (equivalent number of chronic bronchitis cases avoided each year (low estimate): 5667	• Before implementation: 20% of rivers of good, 40% of fair, 25% of poor and 15% of bad quality • After implementation: 60%of good and 40% of fair quality	• Estimate of methane emission reduction per year by 2020 in 1000 tonnes (low estimate): 146.861 • Increase in recycling and composting per year by 2020 in tonnes: 10.215.579	• Percentage of threatened mammal species of all mammal species: 11.9%
Monetised	• Total annual benefits of full compliance (low estimate): 2,600 million Euro/year	• Total annual benefits from full compliance with water related directives (low estimate): 3.674 million Euro/year	• Total annual benefits of full compliance (low estimate): 165 million Euro/year	

Romania

	Air	Water	Waste	Nature
Qualitative	• Improvement of health problems caused by lead pollution (esp. in the ‘hot spots’ of non-ferrous metal industries, Tulcea, Baia Mare, Slatina, Copsa Mica) • Better air quality in heavily polluted large cities, mainly Bucharest	• Water quality of the Black Sea and the Danube will improve • Protection of groundwater of special importance, due to many wells in rural areas • Continuous water supply will be ensured (currently interruptions because of incidents of disease)	• Health risks posed by incinerators not meeting EU standards will be reduced • Reduction of damage caused by non-compliant landfill sites and improper disposal of hazardous waste	• Better protection of Danube Delta (important habitats) • Less pressure on natural resources (esp. in the Carpathian mountains) in hot spots such as Baia Mare • Less damage to forests
Quantitative	• Morbidity impacts (equivalent number of chronic bronchitis cases avoided each year, low estimate): 2493	• Before implementation: 59% of rivers of good, 26% of fair, 6% of poor and 9% of bad quality • After implementation: 85% of good and 15% of fair quality	• Estimate of methane emission reduction per year by 2020 in 1000 tonnes (low estimate): 203.570 • Increase in recycling and composting per year by 2020 in tonnes: 8.502.888	• Percentage of threatened mammal species of all mammal species: 19%
Monetised	• Total annual benefits of full compliance (low estimate): 780 million Euro/year	• Total annual benefits from full compliance with water related directives (low estimate): 306 million Euro/year	• Total annual benefits of full compliance (low estimate): 85 million Euro/year	

Slovakia

	Air	Water	Waste	Nature
Qualitative	• Heavily polluted areas, especially from traffic, such as Bratislava will benefit from better air quality • Pollution from industrial sources will decrease • Better protection of forests (Slovakia is one of the most forested country in Europe)	• Improves bathing water quality beneficial for tourism • More water treatment facilities • Less drinking water contamination with heavy metals • Better protection of transboundary rivers	• There is a big potential for benefits for human health and the environment, regarding the poor state of waste management • Most of the incinerators and landfill sites do not comply with EU standards	• Better protection of natural habitats, especially when close to pollution 'hot spots' such as Bratislava • Preservation and restoration of nine priority areas of strongly to extremely distorted environment • Many endangered species will be protected
Quantitative	• Morbidity impacts (equivalent number of chronic bronchitis cases avoided each year, low estimate): 1304	• Before implementation: 45% of rivers of poor, 28% of poor and 27% of very bad quality • After implementation: 100% of fair quality	• Estimate of methane emission reduction per year by 2020 in 1000 tonnes (low estimate): 19.359 • Increase in recycling and composting per year by 2020 in tonnes: 1.379.739	
Monetised	• Total annual benefits of full compliance (low estimate): 380 million Euro/year	• Total annual benefits from full compliance with water related directives (low estimate): 266 million Euro/year	• Total annual benefits of full compliance (low estimate): 30 million Euro/year	

Slovenia

	Air	Water	Waste	Nature
Qualitative	• Some pollution problems caused by traffic and industrial emissions still exist. Arising health risks will be reduced	• Improvement of bathing water (e.g. in Istria and Lake Bled), important for tourism • Better river water quality	• Higher standards of landfill sites and incinerators will benefit human health and the environment • Higher recycling rates will reduce the amount of waste	• Rich biota of the karst region will be preserved • Better protection of forests (53% of the territory is covered with forest)
Quantitative	• Morbidity impacts (equivalent number of chronic bronchitis cases avoided each year (low estimate): 156	• Before implementation: 45% of rivers of fair, 48% of poor and 7% of bad quality • After implementation: 45%of good and 55% of fair quality	• Estimate of methane emission reduction per year by 2020 in 1000 tonnes (low estimate): 8.411 • Increase in recycling and composting per year by 2020 in tonnes: 840.329	• Expected increase in protected areas (until 2020) as a percentage of each country's total surface area: +26 percentage points (from 6% to 32%)
Monetised	• Total annual benefits of full compliance (low estimate): 70 million Euro/year	• Total annual benefits from full compliance with water related directives (low estimate): 127 million Euro/year	• Total annual benefits of full compliance (low estimate): 25 million Euro/year	

Turkey

	Air	Water	Waste	Nature
Qualitative	• Health benefits will occur from the reduction of emissions from power stations and industry, esp. where these are located close to urban areas such as Istanbul or Izmir • Improved emission standards will reduce problems caused by traffic, esp. in Istanbul	• Protection of bathing waters important for economy (tourism) • Improved protection of ecosystems (lakes and rivers) • Improved drinking water quality and better waste water treatment, esp. in large cities such as Istanbul	• Improvements of the poor state of landfill sites will reduce risks to human health and ecosystems • EU standards will ensure proper disposal of hazardous waste • Recycling is at a very low level, increase will help reduce the amount of waste	• Better protection of habitats due to reduced uncontrolled urbanisation • Increased protection of declared protected areas • Less forests and grassland conversion into arable land • Measures to protect large number of endangered endemic species will be taken
Quantitative	• Morbidity impacts (equivalent number of chronic bronchitis cases avoided each year, low estimate): 26970	•	• Estimate of methane emission reduction per year by 2020 in 1000 tonnes (low estimate): 32.143 • Increase in recycling and composting per year by 2020 in tonnes: 19.687.272	• Percentage of threatened mammal species of all mammal species: 14.7%
Monetised	• Total annual benefits of full compliance (low estimate): 2,180 million Euro/year	• Total annual benefits from full compliance with water related directives (low estimate): 228 million Euro/year	• Total annual benefits of full compliance (low estimate): 77 million Euro/year	

THE BENEFITS OF COMPLIANCE WITH THE ENVIRONMENTAL ACQUIS FOR THE CANDIDATE COUNTRIES

PART B: AIR QUALITY DIRECTIVES

PART B: AIR QUALITY DIRECTIVES

Contents

THE BENEFITS OF COMPLIANCE WITH THE ENVIRONMENTAL ACQUIS FOR THE CANDIDATE COUNTRIES

PART B: AIR (INCLUDING INDUSTRIAL) QUALITY DIRECTIVES *

PART B: AIR QUALITY DIRECTIVES

This part of the Benefits Study presents the assessment of benefits of compliance from the implementation of the air pollution related directives including directive in the Chapter on Air of the *acquis communautaire* and also the air related directives in with Chapter on Industrial Pollution Control. It does not include air related benefits from the implementation of directives in other chapters of the acquis.

This chapter presents the results of the qualitative assessment (nature and type of benefits), the quantitative benefits (extent of benefits), and the value of the benefits (Monetised value) – presented in Chapters 1, 2 and 3 respectively.

This Part B is complemented by a similarly analysis for water and for waste in Parts C and D respectively. An analysis of the benefits from the implementation of the nature related directives is presented in Part E, though no monetisation has been carried out for Part E.

1.0 QUALITATIVE ASSESSMENT OF THE BENEFITS OF COMPLIANCE WITH THE AIR RELATED DIRECTIVES

The discussion on the qualitative benefits covers more directives and benefits than the subsequent chapters on the extent and value of the benefits. The aim of the qualitative analysis is to highlight and explore the range of benefits from each of the directives, and present country examples, where pertinent, of the benefits and their context in the countries. Generally only a sub-set of country specific examples are presented for each benefit type, and lessons from one country are clearly of relevant to some other candidate countries. This attempts to keep Chapter 1 to a more reasonable length. Further shortening could lose some country specific detail, and make the benefits qualitative discussion too general and reduce relevance for readers from across the candidate countries.

1.1 Introduction

Air pollution causes a wide range of environmental problems. The presence of air pollutants in the air can result in pulmonary and cardiovascular illness and early mortality. They can damage vegetation and buildings, including the cultural heritage. Over longer distances such pollutants may be deposited as acid rain leading to acidification and/or eutrophication of ecosystems such as forests and fresh waters and affect economically important resources such as fisheries.

The EU environmental *acquis* tackles the problem of air pollution in a number of ways. Thus it:

- Sets emission limits for individual pollutants from industry and vehicles (including fuel standards);
- Establishes air quality standards for health and ecosystems;

- Requires local management of air quality to ensure cost-effective implementation;
- Requires overall limits to national emissions of specific pollutants in order to reduce acid rain impacts.

The candidate countries have highly variable air quality problems. Acid rain has been a major cause of damage in parts of the Czech Republic and Poland. Ozone concentrations reach levels that are dangerous to health in many countries, especially Bulgaria and Turkey. Older industries have resulted in 'hot spots' where health impacts have been severe, e.g. in southern Poland and Romania. Much of the vehicle fleet is old and still causes significant air quality problems in urban areas such as Warsaw, Bucharest and Istanbul. Thus, implementation of the *acquis* is expected to bring significant benefits. It is important to note that the range of measures identified may each assist in bringing one or more benefits.. Thus, for example, the Air Framework Directive, Vehicle Emissions Directives and the IPPC Directive all have the benefit of reducing health problems associated with nitrogen dioxide pollution.

Table E1 summarises the sub-study coverage of directives and the level of analysis for each directive. For certain directives (e.g. Seveso II (ComaH) Directive) it has not been possible to carry out an evaluation beyond the qualitative step. This does not suggest that this directive has few benefits, but rather that there is insufficient data and/or no robust methodology to come to a quantitative and monetary assessment. The types of benefits are presented further below in Chapter 1 for the Seveso Directive.

Table E1: The Acquis Communautaire, and Level of Analysis

Directive		**Level of Analysis**
B. Air Quality		Monetary assessment
Air Quality Frame. + Daughters: PM10, SO2, lead, N20	96/62, 80/779,amen,	Monetary assessment
Tropospheric Ozone Pollution	92/72	Qualitative analysis
Emissions from motor vehicles, diesel engines, soot, etc	70/220, amen. Etc	Qualitative analysis
VOC emissions from storage and transport of petrol	94/63	Qualitative analysis
Lead content of petrol, quality of diesel, sulphur content.	85/210, amen. Etc	Qualitative analysis
Emissions from non-road mobile machinery	97/68	Qualitative analysis
Regulation – Ozone Depleting Substances	EC/3093/94	General description
F. Industrial Pollution Control		
Air Pollution from Industrial Plants	84/360, amen.	Monetary assessment
Large Combustion Plants	88/609, amen.	Monetary assessment
IPPC	96/61	Monetary assessment
Seveso - Control of Major Accident Hazards	96/82, amen.	Qualitative analysis
Industrial pollution: reduction of emissions of volatile organic compounds (VOC)	1999/13/CE	Monetary assessment
Regulation – Community eco-label award scheme	880/92 & 1836/93	General description

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This chapter explores the directives in the following order:

- The Air Framework Directive (Section 1.2)
- Emissions from Vehicles (Section 1.3)
- Volatile Organic Compounds From Industry (Section 1.4)
- Air Quality – Ozone (Section 1.5)
- Lead In Petrol (Section 1.6)
- Ozone Depleting Substances (Section 1.7)
- Industrial Regulation Directives – IPPC (Section 1.8)
- Large Combustion Plants (Section 1.9)

1.2 The Air Framework Directive

1.2.1 Introduction

The Directive is intended to provide a framework for ambient air quality management in the EC; it does not itself create any precise air quality objectives. It provides for the establishment of new ambient air quality standards and objectives, the assessment of air quality, the provision of information to the public, and the development and implementation of programmes to maintain air quality or to bring it to the desired levels where necessary.

Limit values and alert thresholds for various ambient air pollutants are to be set through daughter Directives, the first of which replaces the existing EC air quality standards defined for sulphur dioxide and particulates, nitrogen dioxide and lead. In fixing limit values and alert thresholds, account is to be taken of a number of factors. These include the degree of exposure of sectors of the population and sensitive sub-groups, sensitivity of flora, fauna and habitats, exposure of historic heritage, and economic and technical feasibility.

Many of the benefits described below will be felt in the short term, given the relatively straightforward dose-response function, time-path and relationship to impacts.

1.2.2 Health benefits

The health consequences of exposure to polluted air are considerable and span a wide range of severity from coughing and bronchitis to heart disease and lung cancer. Vulnerable groups include infants, the elderly, and those suffering from chronic respiratory conditions including asthma, bronchitis, or emphysema. Many of air pollution's health effects, such as bronchitis, tightness in the chest, and wheezing, are acute, or short term, and can be reversed if air pollution exposures decline. Other effects appear to be chronic, such as lung cancer and cardiopulmonary disease. Studies suggest an increase in the death rate of those chronically exposed to dirty air. All of these health effects entail a significant economic cost including the cost to the economy of many person sick days and the costs to national health services.

The first daughter Directive provides EC air quality standards defined for sulphur dioxide and particulates, nitrogen dioxide and lead.

- The known health effects of lead poisoning which could be avoided through the use of unleaded petrol include: anaemia, brain and nervous system damage (sometimes resulting in death), severe kidney injury, injury to the gastrointestinal system, the heart, the reproductive system and impaired foetal blood synthesis.

- Health effects caused by exposure to high levels of SO2 include breathing problems, damage to the lung's defences, and worsening cardiovascular and respiratory disease. Sulphur dioxide may also lead to increased mortality, especially if elevated levels of suspended particles are also present. The London smog of 1952 has been attributed with over 4,000 deaths.

- Long-term health effects remain a possible consequence of exposure to particulate pollution. Studies have shown a correlation between rises in PM_{10} concentration, and increases in emergency-room visits due to asthma, and also hospital admissions on the grounds of respiratory diseases.

- When NOx is combined with ozone, organic compounds, particulates and sunlight, a photochemical ‘smog’ is formed. The health effects of this cocktail of pollutants include respiratory impairment, irritation of the eyes and possible irritation of the mucous membrane, with asthma patients and young children thought to be the most susceptible to the effects.

Specific benefits likely in candidate countries include:

- In Bulgaria, implementation will decrease the health risks and especially the health risk in 14 regions identified as pollution “hot spots”.

- Improvement of the health in presently heavily polluted areas especially in industrial areas of North-east Estonia.

- Around a half of population of Latvia is living in seven cities where the main air pollution sources occur. Significant health benefits are expected from approximation to the acquis.

- In Lithuania it is expected that reduction in emissions and traffic management will aid air quality improvement in cities such as Vilnius and Kaunas.

- In Malta the most serious air pollutants are principally those emitted the power station of Marsa (close to an urban area), incinerators and industrial plants. The implementation of this directive would have positive health impacts (associated with reduced sulphur dioxide emissions and lower levels of particulate matter), on the nearby communities that suffer from the combined effect of sulphur dioxide, suspended particles and water vapour.

- In Poland, health benefits are expected since implementation will press local authorities (where current air protection standards are very often exceeded) to prepare air protection plans. It is understood that a large part of Poland is likely to exceed the limit values of the daughter directives and, therefore, compliance will result in major health benefits to large sections of the population.

- In Romania children of age 7-14 have been identified as the most vulnerable to the adverse health effects of exposure to lead-pollution in the “hot spots” of non-ferrous metallurgical industries – Tulcea, Baia Mare, Slatina, Copsa Mica. Improving air quality standards would reduce the incidence of respiratory diseases and somatic disturbances in children (A 1-1.5 year of lagging behind in overall development).

- In the Slovak Republic emissions of the main pollutants (CO, SO_2, NO_x and particles) have been decreasing over the last decade (mostly due to transition of economy and closing of large scale polluting enterprises and improved legislation and law enforcement). However, further decrease in pollution will improve health especially in the most polluted spots such as Bratislava, Michalovce District and Prividza District.

- In Turkey smog and particulate matter resulting from using low quality (high sulphur) fuels (mostly lignite) and unleaded fuels in Ankara until early 1990's and presently in many urban settlements including Istanbul between October and March is among the main causes of respiratory related problems.

1.2.3 Non-health economic exploitation benefits

Sulphur dioxide along with nitrogen oxides are the main precursors of acid rain, which have been known to cause severe damage to crops, forests, lakes and streams world-wide. These gases can travel long distances often resulting in acid deposition in countries outside their origin. The 'Black Triangle', which has resulted from transboundary pollution of SO2 in several of the candidate countries, will benefit (and indeed are already benefiting) from this legislation.

Sulphur dioxide and nitrogen oxides, in their gas form, also contribute to crop damage though the degradation of chlorophyll. Reducing the release of these gases in the atmosphere will bring tangible benefits to agriculture, agro-forestry and fisheries industries. In addition, SO2 and NOx are known to corrode building structures at great economic cost.

Specific benefits likely in candidate countries include:

- The built environment of Malta is very much shaped by Lower Globigerina Limestone that is used in buildings, structures as facing stone, decorative purposes and restoration of historic monuments and buildings. This industry stands to benefit directly from reduced damage to the stone that is quarried and sold.

- In Poland acidification is a significant threat and therefore reduction of SO_2 and NO_x emissions and establishing of proper standards will reduce losses in the agriculture and in forestry.

- In Romania soil pollution by heavy metals (around the "hot spots" as above) has been estimated to result in loss of agricultural output of about 20% per year.

- The Slovak Republic "imports" more emissions than it "exports". The deposition of emissions from Katowice (Poland) and Ostrava (Czech Republic) is a serious problem for North part of Slovakia. Thus Slovakia will indirectly benefit from stricter standards in these two neighbouring countries.

1.2.4 Ecosystem benefits

The Air Framework Directive introduces the first air quality standards for ecosystem protection, the result of which will be a range of significant benefits.

Damage to forests, lakes and streams from acidification resulting from SO_2 and NOx has a major impact on the health of ecosystems and biodiversity in general. In some cases, existing production may have caused critical loads to be reached in ecosystems and much damage will be irreparable. High concentrations of lead also adversely affected domestic animals, wildlife and aquatic life.

More indirectly, the effects of climate change, contributed to by NOx and SO2, are as of yet not fully known, but potentially very damaging to global ecosystems.

Specific benefits likely in candidate countries include:

- In the Czech Republic and Poland critical loads for many ecosystems are exceeded. Therefore implementation will significantly help to reduce this problem, especially because SO_2 and NO_x emission reduction will take place not only in the Czech Republic Poland but also in its neighbour countries e.g. Estonia and Hungary.

- In Romania ecosystem benefits are particularly important, to protect virgin/natural forests that still exists – in the south-western part of the country, especially as some of the pollution “hot spots” are situated in areas of outstanding natural landscapes (Zlatna).

- In Slovakia the impact on forestry is very important, as it is one of the most forested countries in Europe. These forests are under threat from air pollution.

1.2.5 Social benefits

The social benefits of reduced pollution to air are myriad and relate to improvements to the quality of life (e.g. through reduced health effects), the increased amenity value of improved landscapes, nature and air quality (through reduced pollution pressure), and reduced damage to cultural heritage such as historic building surfaces in city centres.

The Air Framework Directive sets out a number of public information requirements, such as alerting the public when threshold limits have been exceeded. Informing and involving the public in environmental and health matters not only helps build trust within communicates and between communities and government (and potentially industry) and can improve social cohesion. More routine information requirements not only specify information provision to the public in general, but also to a range of listed interested groups. In many countries information supply to the public is poor, especially for socially excluded groups. The Directive requires that such provision is active and this will be especially important for disadvantaged sections of society in urban areas that might suffer from particularly poor air quality. Information on ambient concentrations of sulphur dioxide, nitrogen dioxide and particulates are all to be made available on a daily basis and, where practicable, on an hourly basis, while that for lead is to be available on a three-monthly basis.

Specific benefits likely in candidate countries include:

- In Malta the provision of information to the public is quite weak especially in the field of air pollution where regular monitoring is not carried out. People may be unaware of the risks and health problems associated with certain activities such as road transport. Increased information may help avoid some polluting activities or exposure to pollution.

- In Poland it is believed that after implementation of the directive, local society will have more direct influence on the local authorities, and will be also able to evaluate activities undertaken by the local governments to protect quality of local air.

1.2.6 Wider economic benefits

A wide range of environmental technologies and new ‘cleaner’ primary inputs, are required to bring about cleaner production processes that will be needed to meet the standards in these directives. These industries will benefit economically from increased sales as will society from increased employment in these sectors. There will also be benefits derived from improved tourism in areas that were previously damaged by acid rain.

Specific benefits likely in candidate countries include:

- Many of the Czech spa areas are located within the region with more polluted air. Cleaner air can contribute to development of health resort industry and extending the scope of related services, and creating new employment opportunities.

- In Malta, reduced pollution and cleaner air might encourage more tourism and reduce damage to cultural heritage. The Maltese Islands are richly endowed with historical and cultural heritage resources that attract tourists. Since buildings, monuments and statues are made from limestone, damage to buildings especially architecturally/archaeologically important buildings involve restoration costs.

- In Poland areas of Silesia are damaged by acid rain, and it is expected that improved air quality may aid in the development of tourism.

- In Turkey the smog and particulate concentrations between October and March in some provincial centers causes the working hours to be shortened or whole days lost. Compliance with the directive would thus reduce loss of working periods to a minimum.

1.3 Emissions From Vehicles

1.3.1 Introduction

The many Directives that fall under this heading regulate emissions of vehicles or engines directly. They were introduced primarily to prevent the Member States creating barriers to trade by setting more stringent standards than those specified, however environmental considerations are now being given greater prominence in their own right. The four main emissions for which limits are set are carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (NOx) and particulates. The vehicles and engines covered by the directives are:

- Petrol and diesel passenger cars;
- Diesel engines in heavy duty vehicles;
- Cars fuelled by petroleum gas or natural gas;
- Motorcycles (two and three wheeled vehicles); and
- Tractors and other non-road machinery.

The Directives also cover the testing of vehicles and the monitoring of emissions.

1.3.2 Health benefits

Reducing emissions from vehicles will constitute a significant improvement in the health of exposed populations and bring the associated economic benefits to the public health sector and to society at large, particularly in urban areas. An indication of the size of this benefit is provided by a recent WHO report that puts the annual death toll in Europe from air pollution, which could be linked to road traffic pollution, at 80,000. Work by the EEA has shown the positive effect on emissions that emissions legislation has had on transport emissions in the EU. Emissions of NOx and particulates have been declining steadily since 1990.

Health and accident risks of CO include, at low levels of exposure: drowsiness, dizziness, confusion and fatigue. Whereas continued exposure can lead to vomiting, loss of consciousness, brain damage, heart irregularity, breathing difficulties, muscle weakness, abortions and even death.

Carbon monoxide can reach levels that are dangerously high for people in situations where traffic fumes can accumulate. In cities, about two-thirds of the carbon monoxide emissions come from transportation sources, with the largest contribution coming from highway motor vehicles. In urban areas, the motor vehicle contribution to carbon monoxide pollution can exceed 90 percent. Carbon monoxide emissions from automobiles also increase in cold weather. This is because cars need more fuel to start at cold temperatures, and because some emission control devices (such as oxygen sensors and catalytic converters) operate less efficiently when they are cold. Therefore the health risks associated with CO exposure will be higher in those candidate countries where traffic density is combined with frequent cold weather.

Long-term health effects remain a possible consequence of exposure to particulate pollution. Studies have shown a correlation between rises in PM_{10} concentration, and increases in emergency-room visits due to asthma, and also hospital admissions on the grounds of respiratory diseases.

When in isolation, the health effects of nitrogen dioxide are relatively small compared to others. However, when combined with ozone, organic compounds, particulates and sunlight, to form a photochemical cocktail of pollutants, the health effects increase significantly. Respiratory impairment, irritation of the eyes and possible irritation of the mucous membrane are all known to occur at acute levels, with asthma patients and young children thought to be the most susceptible to the effects.

Specific benefits likely in candidate countries include:

- In Bulgaria the health risk from air pollution caused by vehicles will be reduced in large cities as Sofia, Varna, Plovdiv and Rousse.

- In Estonia implementation will improve the air quality in bigger towns (Tallinn, Tartu and Pärnu).

- In Latvia the number of cars is increasing and the daily maximum admissible concentrations of air pollutants have been exceeded in several of the biggest cities. Reduction in emissions will result in significant health benefits.

- This Directive will have important health impacts for Malta. There are a large number of vehicles in Malta (in 1997: 164,873 licensed private cars, or 1.5 cars per household significantly higher than the average in the candidate countries). Pollution levels are especially high in congested areas such as Msida and Floriana.

- In Poland the health benefits from the implementation of the directive should be high given that many vehicles are old and do not meet emission limits and that car use has increased to levels which cause congestion in major cities such as Warsaw and Katowice. The increase in vehicle emissions is already offsetting the benefits gained from reduced industrial production and reduction in emissions from that source.

- In Romania the combined effects of pollutants in the centre of Bucharest (particulates, NOx, CO) generate eye and throat irritations, affecting job performance (especially for teachers). Improving fuel quality will enhance the quality of life in all urban centres.

- In Slovakia increasing individual transport is very significant problem for the bigger cities (especially Bratislava) where there is a large shift from public transport towards cars. Therefore, stricter EU emission limits will be increasingly important for health protection.

- In Turkey unleaded petrol has only been in use for six years. Only specific models of passenger cars utilize catalytic converters. Trucks that run with diesel fuel are the greatest source of CO, particulate matter (unburned carbon) and NOx emissions on the highways. There are no reliable statistics for number of deaths because of air pollution. However, severe health problems (respiratory) are related to the emissions of vehicles especially in the winter months.

1.3.3 Non-health economic exploitation benefits

NO_x can seriously injure vegetation at certain concentrations. Effects include bleaching or killing plant tissue, causing leaves to fall and reducing growth rate. This damage when it accrues to the agricultural sector amounts to economic losses and thus reducing this damage will bring a clear economic benefit. Oxides of nitrogen are also known to corrode metals (due to nitrate salts formed from nitrogen oxides) and hence reducing emissions will reduce damage to building structures and mean avoided costs to a variety of economic actors.

NO_x is also a precursor to acidic precipitation, which may affect both terrestrial and aquatic ecosystems and hence marine based and agricultural production. Acid rain also causes damage to buildings.

Specific benefits likely in candidate countries include:

- In Bulgaria agricultural production around the big cities and near highways, will benefit most.

- In Estonia there is expected to be less damage to historical buildings, especially in Tallinn.

- In Poland many agricultural areas are located near roads – pollution emitted by cars has contaminated soils and reduced yields. The use of better quality petrol could reduce the damage to agricultural land. Also the implementation of the directive should reduce the negative effect of transport emissions on buildings in urban areas.

- In Romania emissions from cars greatly damage vegetation in big cities (Bucharest, Constanta, Timisoara), making it practically impossible to maintain green plantations along the main boulevards and thoroughfares.

1.3.4 Ecosystem benefits

As well as contributing to acidification, emissions of NOx can contribute to the eutrophication of soil and water, which can adversely effect the functioning of ecosystems.

Specific benefits likely in candidate countries include:

- In Estonia the ecosystem near to the Tallinn-Tartu, Tallinn-Narva and Tallinn-pärnu highways will be much less threatened.

- In Slovakia these Directives are especially important as the main transport corridors from the North to South and West to East often cross (or are very close to) areas with rich biodiversity.

- For Turkey high acid concentrations resulting from SO_2 and NOx as well as lead from unleaded fuels are great concerns for the forests, wildlife, aquatic life and ecosystems as well as for special areas of environmental protection.

1.3.5 Social benefits

The benefit of increased visibility in urban areas, as a result of reduced photochemical smog, will result in an increase in the quality of life of inhabitants. Transport emissions are a major contributor to poor urban air quality and compliance with them is one component of any comprehensive social improvement policy. Black smoke from traffic is a prime cause of discolouring of buildings, including public buildings of important social cultural value, such as monuments, historic buildings, churches, museums. Reduced blackening and erosion of surfaces (from SOx and NOx emissions from traffic fuel use), can improve the social appreciation and use of city centres and cultural heritage.

1.3.6 Wider economic benefits

The vehicle emissions directives are not only important for environmental protection, but are also fundamental to access to and the operation of the single market. All vehicles sold in the Member States must comply with these standards and some might argue, therefore, all business that manufacture cars or car components will benefit from compliance. Compliance will also ensure that sub-standard vehicles from other competitors are no longer allowed. Thus investment to meet these standards will provide competitive advantages both inside and outside the candidate country. Where the candidate country industry products comply with the EU internal market standards[1], there should be a significant opportunity for economic growth[2]. Furthermore, as the candidate countries become part of the EU, third country manufacturers who do not comply with the EU standards will have a reduced entrance to the candidate country market themselves, supporting the candidate country industry.

Cleaner air can also attract more visitors to cities and other areas previously affected. A variety of industries would benefit economically from an increased flow of tourists and other visitors.

Another economic benefit will arise from the benefits of growth in environmental industries[3], which will be required to meet the needs of vehicle and other manufacturers to meet the requirements of this legislation (e.g for the production of catalytic converters).

[1] Compliance with standards is a pre-requisite for being able to sell goods on the EU internal market.
[2] This is already manifest.
[3] Where there are certain "winners" in the restructuring, then there are likely to also be "losers", depending on which product substitutes which other product, or where funding is diverted from to be able to fund

Specific benefits likely in candidate countries include:

- In the Czech Republic the vehicle industry is an important revenue source and compliance with emission limits has been instrumental in its success in the vehicle market of the current Member States.

- In Romania the car industry in Pitesti (Dacia-Renault) will comply with the directive requirements for its new product to be launched soon

- A significant part of Slovak exports results from production of Volkswagen cars. The Slovak government actively promotes car producers to invest in the country.

- Manufacturing and export of cars has been one of the major industrial activities in Turkey with many international car manufacturers. Compliance of these cars with the EU legislation will boost this industry. Compliance will also help the car parts industries in regions such as Bursa to expand their economic activities.

environmental goods and services. It is beyond the scope of the present study to carry out an analysis of the likely winners and losers and the likely "net" benefits.

1.4 Volatile Organic Compounds from Industry

1.4.1 Introduction

This Directive is intended to reduce emissions of volatile organic compounds (VOCs) from the use of solvents in certain sectors of industry. It complements other EC measures that aim to control VOCs in their own right as well as limiting the secondary air pollutants whose formation VOCs may lead to, and in particular ozone, in support of both Community goals and international agreements.

1.4.2 Health benefits

VOC's are a group of organic compounds in products such as gasolines, paints, paint thinners, and solvents used for dry cleaning and metal degreasing. VOCs (solvent fumes and vapours) are classified as "pre-cursor" compounds. These compounds react in the presence nitrogen oxides and ultraviolet light found in sunlight to produce ground-level ozone and other compounds (or 'smog'). This contributes to the smog-related health concerns described in previous sections, such as respiratory illnesses. Some individual volatile organic compounds are believed to be a threat to human health. For example, benzene has been implicated as cancer-causing and hexane as a cause of nervous system disorders.

Volatile organic compounds (VOC's) in ground water is a potential human health concern for those using ground water as a drinking water supply. Gasoline and other substances containing VOC's can find their way into the ground water through point sources such as leaking storage tanks or direct spills. Compounds also can enter the ground water from non-point sources, such as through stormwater runoff from roads and parking lots. Some airborne compounds can mix with rain, and rainfall containing VOC's also may recharge aquifers as a non-point source of contamination.

Specific benefits likely in candidate countries include:

- In Estonia implementation will lead to the improvement of the air quality in the Kohtla-järve and Kiviõli towns (centres of oil-shale based chemical industry) and improvement of the health of oil-shale industry workers.

- In Slovakia tanks and storage of substances containing VOCs are in a poor condition and transition period up to 10 years will be asked for this Directive. There is no estimate of health effects due to these leakages, yet implementation is expected to have significant positive benefits.

1.4.3 Non-health economic exploitation benefits

The most important benefit will accrue to those forests and agriculture, which experience high ozone concentrations. Here some damage may occur leading to reduced productivity. The exact impacts are rarely quantified, although they may be important in some instances.

1.4.4 Ecosystem benefits

Ozone impacts on vegetation at concentrations not far above ambient background levels. It can cause damage to natural ecosystems and to crops. The effects of ground-level ozone on long-lived species such as trees are believed to add up over many years so that whole forests or ecosystems can be affected. For example, ozone can adversely impact ecological functions such as water movement, mineral nutrient cycling, and habitats for various animal and plant species. Ground-level ozone can kill or damage leaves so that they fall off the plants too soon or become spotted or brown.

1.4.5 Social benefits

Inhabitants of major cities and those living near production sites where VOCs are emitted will benefit from reduced smog and unpleasant odours, which is a general nuisance. Specific benefits likely in candidate countries include:

- In Turkey unpleasant odours and smog will be reduced around the areas such as, Sapanca Lake (a major drinking water reserve in the Marmara region in Turkey) where VOC concentrations will be lowered and inhabitants will not be subject to this nuisance.

1.4.6 Wider economic benefits

Industries offering systems for VOC abatement, filtration and control will benefit from this legislation.

1.5 Air Quality – Ozone

1.5.1 Introduction

The Directive does not set air quality limit values for ozone. Rather, in order to obtain a wider knowledge of ozone levels within the Community, the directive requires the establishment by Member States of a consistent basis of ozone monitoring networks, and the sharing of monitoring information between the Commission and the Member States so as to aid the development of future measures for the control of photochemical pollution. Warnings are to be given to the public, through print and broadcast media) in the event of ozone levels exceeding certain thresholds.

1.5.2 Health benefits

Ground-level ozone is created when certain pollutants, known as "ozone precursors", react in heat and sunlight to form ozone. Cars and other vehicles are the largest source of ozone precursors; hence ozone levels are usually highest in cities at the peak of summer. Due to the complex chemistry of ozone production in the atmosphere ozone pollution is usually a problem in the Southern cities of Europe and not the northern cities. In the northern countries, ozone presents a greater problem in rural areas. Other important sources of ozone include industrial facilities, power plants, gasoline-powered mowers, and evaporation of solvents, paints, and other chemicals.

Most of the health effects of ozone are immediately felt and short lived, although scientists are concerned that repeated short-term damage from ozone exposure may cause permanent injury. Ozone impacts on human health by:

- Reducing lung function, (symptoms include coughing, irritation in the airways, rapid or shallow breathing, and discomfort when breathing or general discomfort in the chest);
- Aggravating asthma by making asthmatics more sensitive to allergens and through the reduced lung function and irritation;
- Inflaming and damaging the lining of the lung (similar to a sunburn repeated damage could have long-term health effects); and
- Other effects on people's health may include aggravating chronic lung diseases and reducing the immune system's ability to fight off bacterial infections in the respiratory system.

Ozone presents a particular problem to children, asthmatics, outdoor workers, competitive athletes, and other people who exercise outdoors. People can reduce their exposure to ozone if they are aware of areas and times of the year when ozone levels are high. They can avoid going out in high-risk periods with their children, avoid living in certain areas and avoid exercising when ozone levels are high.

By providing information to the public, this directive can have a direct effect on protective action taken by the public and thereby reduce the health impacts of ozone. The longer-term benefit of provision of information on ozone is in developing more direct measures to combat petrochemical pollution directly.

Specific benefits likely in candidate countries include:

- In Poland there will be benefits for citizens of urban areas where car traffic is an important source of ozone. After implementation of the directive requirements it will be easier to control if local authorities undertake actions to protect local air quality and reduce ozone concentrations in the air.

- In Romania reducing the concentration of ozone is particularly important in hot summer spells in urban centres (notably in Southern Romania); high temperatures and low wind contribute to the ozone problem;

- In Turkey provision of continuous and reliable information on ozone will help the general public to be aware of the potential risks to health and encourage avoidance of exposure. This is an important matter for Turkey since it has provincial centers with similar characteristics to southern European cities (as Romania above), making ozone a particularly important problem.

1.5.3 Non-health economic exploitation benefits

Ground-level ozone has been shown to reduce agricultural yields for many economically important crops (e.g., soybeans, kidney beans, wheat, cotton). By interfering with the ability of plants to produce and store food, growth, reproduction and overall plant health are compromised. Ozone also makes plants more susceptible to disease, pests, and environmental stresses.

Ozone reacts with nitrogen oxide to produce nitrogen oxides, which contributes to fish kills and algae blooms in sensitive waterways and thereby impacts negatively on fishing enterprises and recreational industries revolving around effected waterways.

Through monitoring of ozone levels and the provision of information to the public and between Member States, implementation of the directive will be a first step towards preventative measures (avoidance through knowledge, plus increased pressure to reduce ozone formation through increased standards, traffic circulation limitations/management. For example, ozone standards adopted in the US are expected to reduce losses to agricultural yield by $500 million.

Specific benefits likely in candidate countries include:

- Monitoring ozone levels in agricultural areas on the Aegean and Mediterranean coastal lines in Turkey is beneficial for controlling crop yields in the agricultural southern provincial centres (e.g., Denizli, Içel, Adana – cotton production). Also, ozone monitoring in areas that are under special environmental protection will provide positive benefits for tourism.

1.5.4 Ecosystem benefits

The effects of ground-level ozone on long-lived species are believed to add up over many years so that whole forests or ecosystems can be affected. For example, ozone can adversely impact ecological functions such as water movement, mineral nutrient cycling, and habitats for various animal and plant species. Ground-level ozone can kill or damage leaves so that they fall off the plants too soon or become spotted or brown, reducing their photosynthesis capacity.

1.5.5 Social benefits

The ecosystem effects described above can significantly decrease the natural beauty of an area and thereby reduce the quality of life of those benefiting from the amenity value of these areas. By increasing awareness of ozone levels and especially the thresholds for protection of vegetation, the directive should encourage action in this area.

1.5.6 Wider economic benefits

There are no obvious wider economic benefits arising from implementation of this Directive.

1.6 Lead in Petrol

1.6.1 Introduction

This Directive prohibits the sale of leaded petrol from 1 January 2000. There is clearly a link with the vehicle emissions directives. However, the latter apply generally to new vehicles and the requirement for catalytic converters has reduced the use of leaded petrol significantly. The fuel Directive is an additional component to reducing air pollution from vehicles by tackling the problem of emissions of lead from older vehicles.

1.6.2 Health benefits

Air-borne lead is readily absorbed by the body via inhalation. Studies indicate that 10% to 20% of inhaled lead enters the blood stream. Known health effects of lead, poisoning, which could be avoided through the use of unleaded petrol (assuming no other sources exist, e.g. waterborne) include:

- Anaemia.
- Brain and nervous system damage, which can include permanent mental and motor retardation and in extreme cases, death.
- Severe kidney injury or failure.
- Injury to the gastrointestinal system and the heart.
- Damage to the reproductive system, including:
- Ovarian and testicular dysfunction.
- Impaired foetal blood synthesis, premature births, and other delivery complications.

Long-term, low-level lead exposure causes learning deficits and behavioural problems in children. Recent studies suggest that lead may also be a factor in high blood pressure and subsequent heart disease.

Specific benefits likely in candidate countries include:

- In Latvia the concentration of lead in hair of people living in cities is around ten times higher than for people living in rural areas – an indication of the scale of the reality of the problem. Thus a reduction in lead emissions is likely to produce major health benefits.

- Leaded petrol containing tetraethyl lead is the main source of airborne lead-containing particles in the ambient air in Malta. Positive health impacts are expected in Malta with the implementation of this Directive since studies have shown high levels of lead in the environment and in particular in the blood of the local population.

- In Slovakia there is a policy to progressively phase out leaded petrol. As leaded petrol is phased out, potential benefits may result from the fact that many people live very close to the main transport corridors, and there is strong tradition to raise their own fruits and vegetables in private gardens, very often adjacent to a road. The concentration of lead in these products may affect human health.

- In Turkey benefits from reducing lead via inhalation are expected to be important considering present traffic conditions. In addition to inhalation, major health benefits are expected to be witnessed in drinking water reserves such as Sapanaca Lake (Marmara region) and Cekmece lakes (in Istanbul) as highways with heavy traffic have been the major source for the lead concentrations.

1.6.3 Non-health economic exploitation benefits

There are no obvious non-health related economic exploitation benefits.

1.6.4 Ecosystem benefits

At common low ambient concentrations lead does not usually pose a threat to plants and animals. However, exposure to high concentrations has adversely affected domestic animals, wildlife, and aquatic life. For example, small animals trapped near highways have shown high lead levels.

1.6.5 Social benefits

The main social benefit will derive from a reduction in mental development problems for children, which sometimes lead to special assistance needs. Furthermore, parental concerns and anxiety, related to the adverse impacts on children, are likely to fall - as awareness of (and confidence in) air quality improvements grows.

Specific benefits likely in candidate countries include:

- In Poland banning leaded petrol would reduce levels of lead in blood and therefore lead to improved social welfare, quality of life and fewer special assistance needs.

- In Turkey children living in crowded urban environments (in cities such as Istanbul, Ankara and İzmir) and travelling daily for their schooling needs will benefit greatly by not inhaling lead from traffic.

1.6.6 Wider economic benefits

Banning leaded petrol would provide an economic benefit to those industries already involved in the production of unleaded petrol.

1.7 Ozone Depleting Substances

1.7.1 Introduction

The Regulation is intended to implement the Montreal Protocol to the Vienna Convention for the Protection of the Ozone Layer (see Section 13.2), as amended in London in June 1990 and in Copenhagen in November 1992 and indeed to go further. The Regulation bans and restricts a number of other ozone depleting substances as well as Chlorofluorocarbons (CFCs).

CFCs destroy the ozone layer that protects the earth from harmful radiation, leading to increase risk of skin cancer and cataracts. CFCs were formerly used as propellants in aerosol spray cans, in refrigeration and air conditioning plants, and as solvents.

The benefits that accrue from this Directive are global. Therefore it will be impossible to estimate country specific health and environmental benefits as these depend on complex interactions in the global atmosphere and will benefit some countries more than others.

1.7.2 Health benefits

Depletion of the ozone layer will increase the UV-radiation at ground level. Increasing doses of UV-B may cause skin cancer, eye cataracts, and damage to the immune system (in humans and animals as well). Also the development of a new and growing market of substitute products.

1.7.3 Non-health economic exploitation benefits

Increases in UV-radiation will have an adverse impact on plant growth and thereby result in losses to agricultural productivity. Thus, avoiding such increases will bring an economic benefit. In addition to increases in annual UV dosage, transient depletions in ozone in the spring may cause invisible "UV storms" which could prove particularly harmful to vulnerable young plants and animals in very early developmental stages, such as fish in shallow water. These damaging effects also accrue to agricultural, fisheries and other industries, potentially arising in economic losses.

1.7.4 Social benefits

There are no additional social benefits.

1.7.5 Wider economic benefits

Elimination of CFCs from the production of many goods is now a requirement for international trade. Failure to comply with these standards could entail a significant economic cost.

1.8 Industrial Regulation Directives: IPPC

1.8.1 Introduction

The IPPC Directive aims to control emissions from industrial sources to all environmental media through an integrated approach. IPPC applies to major industrial activities and is wide-ranging, applying to six categories of industry: energy; production and processing of metals; minerals; chemicals; waste management; and ‘other’, which covers, for example, intensive pig and poultry farming.

The Directive regulates industrial installations through a permit system whereby operators need to obtain a permit from the local authority in order to operate. The permit sets emission limit values (ELV) based on the ‘Best Available Techniques’ (BAT), which are to be used to ensure the necessary level of environmental protection. However, standards specified in various existing EC instruments are to serve as minimum emission limit values.

The IPPC Directive will help candidate countries in implementing existing legislation in air, water and land management and may result in extra benefits. There is great scope for the IPPC Directive through the application of BAT to reduce emissions well below those limits set or implied by EU legislation in these areas. Determination of BAT will take account of the technical characteristics of the installation, economic factors, its geographical location and local environmental conditions; thus, it is difficult to predict how BAT will be applied in candidate countries (especially as implementation has only just begun in Member States) and hence the level of benefit which can be expected.

1.8.2 Health benefits

The health benefits to be gained from the IPPC Directive will be proportionate to the amount by which the directive can achieve greater emission reductions than those set out in other legislation. However, the directive provides a powerful and potentially very efficient tool for achieving the objectives of the water, waste and air *acquis* and shed in this light will provide enormous benefits to the health of society in all of the candidate countries. The extent of coverage of industries and of pollutants by the directive means that the impacts should be wide reaching and profound. Benefits through reduced air pollution will be especially remarkable in the short term, given the relatively straightforward dose-response function and relationship to impacts. IPPC should help significantly to address, for example the problem of the ‘Black Triangle’, which has resulted from transboundary pollution of SO_2.

Under the IPPC Directive it is expected that where industrial emissions result in impacts on health that the determination of BAT should ensure that these impacts be eliminated. This will be particular important in areas where industry is concentrated (e.g. southern Poland) where implementation will ensure that the relative impacts of different industrial sources can be compared. IPPC is explicitly linked to other parts of the *acquis*. Most importantly it requires that emissions should not lead to an excedence of health standards set out as limit values under the air framework Directive. Compliance will, therefore, cause dramatic improvements in health in industrial areas.

When it comes to persistent pollutants that accumulate in bio-organisms and those others that accumulate in certain environmental media and conditions, the immediate related health benefits of IPPC of reducing these will be less evident. However, by introducing BAT and thereby reducing the flow of hazardous chemicals and other noxious pollutants, greater risks to human health will be avoided in the future.

Specific benefits likely in candidate countries include:

- In Poland there is significant heavy industry (especially in the south) and the potential for widespread use of intensive animal rearing (especially with the future membership of the single market). IPPC is essential to ensure a comprehensive approach to reducing the health and other impacts of pollution from these.

- IPPC which will significantly influence environmental protection and management in Slovakia. Positive impacts are expected because of integrated approach to the environmental protection.

- In Romania 873 industrial units will require IPPC licensing. Currently, out of those only 25% are authorised (and 80% of those licensed do not comply). Thus effective regulation should result in a significant reduction of pollutants hazardous to health.

- In Turkey many industrial processes are sited close to residential areas. This can result in a range of air quality problems, particularly for particulates and acid gases. Locally air quality limit values are often exceeded which may lead to health problems, particularly for sensitive population sectors. Thus efficient and effective implementation of IPPC will lead to significant pollution reductions and subsequent health benefits.

1.8.3 Non-health economic exploitation benefits

The improvement of environmental media will impact positively on those industries affected by pollution in the local area. This includes positive impacts on fisheries and other aquatic based industries receiving reduced emissions to water. For air, if the industrial installation is close to towns and cities there will be reduced damage to buildings and in the countryside reduction in SO_2 will improve the well-being of forestry and fisheries industries previously affected by damage from acid deposition. Reduced land contamination from chemicals emissions and hazardous waste as well as the reduction of waste to landfill will all benefit developers in need of land and the property market.

1.8.4 Ecosystem benefits

Air, water pollution and pollution from waste, can have a wide variety of impacts on biodiversity. Impacts concerning these are described in the description of benefits on individual air and water pollution Directives. However, it is important to note that BAT determination under IPPC must ensure that environmental quality standards established in EU legislation are complied with. These include the requirements for favourable conservation status under the habitats Directive and ecological quality objectives under the water framework Directive. Where industry causes significant biodiversity damage, it is expected that IPPC will be implemented so as to prevent or minimise this impact.

Specific benefits likely in candidate countries include:

- In Poland there will be benefits from a reduction of resource use and waste minimisation should positively influence the land protection. Significant benefits are expected in southern Poland where extensive ecosystem damage has occurred in the past.

- Turkey, being a country of important tourism activity and very rich ecological systems will greatly benefit with the reduced emission of pollutants; this will safeguard the ecological, bathing and other tourist attractions.

1.8.5 Social benefits

The social benefits of reduced pollution to air, water and land which will result in cleaner industrial production processes are many. These include improvements to the quality of life, which arise from the increased amenity value of improved waterways, landscapes and air quality.

Aside from direct benefits from the positive changes in the environment, society will benefit from the directive through provisions that provide for access to environmental information. Member States are required to ensure that applications for IPPC permits are made available for public review and comment before decision is reached. The decision to grant a permit, the permit itself and any updates thereto also must be publicly accessible, as must the results of any monitoring of releases under the permit. Public awareness and participation in local government decisions is an important element in creating social cohesion and social capital.

1.8.6 Wider economic benefits

The Directive should have quite a dramatic impact on the environmental technology industry, where this operates in candidate countries. It will also prove beneficial for suppliers of BAT, alternative chemicals and fuels as inputs to ‘cleaner production’ (and hence less for suppliers of substituted products and technologies). Implementation of the directive will require a large number of environmental professionals to conduct assessments of BAT and other aspects required for permit application and approval. Hence it is expected that the economy will benefit from growth in environment sector jobs and businesses needed to meet the demands of industry to comply with the legislation.

Another element of the IPPC Directive that will bring knock-on benefits is the creation of the European Pollutant Emission Register. The Directive requires the development of a pollution emission register, which is now embodied in Decision 2000/479 requiring that data be supplied by Member States to the Commission from June 2003 onwards. The EU wide register will cover 50 pollutants, including major air pollutants, the six greenhouse gases included in the Kyoto Protocol, heavy metals and chlorinated organic compounds. It is estimated that around 20,000 installations will be covered in the 15 Member States so far. In addition to other benefits that this information will bring to policy makers and society as a whole, the EPER could bring very real financial and economic benefits by aiding implementation of the Kyoto Protocol; and more specifically, Joint Implementation projects (whereby investment may be made from western countries seeking carbon credits to meet their greenhouse reduction targets), from which the candidate countries stand to gain significant investment in cleaner technology.

1.9 Large Combustion Plants

1.9.1 Introduction

The purpose of the directive is to tackle one of the principal causes of acid rain by limiting emissions of sulphur dioxide (SO_2) and nitrogen oxides (NO_X) from fossil-fuelled power stations and other large combustion plants such as oil refineries. It also restricts emissions of dust. Different requirements are set for new and existing plants. Existing plants, i.e. those licensed before 1987, are subject to total national emission limits laid out in the directive with phased reductions. For new plants, emissions limits applicable to individual authorisations are defined based on ‘best available technology not entailing excessive cost’.

1.9.2 Health benefits

The health benefits arising from implementation of this Directive could be quite substantial, but depend on the amount by which SO_2 and NOx are reduced. In the 12 Member States that comprised the EC at the time the directive was adopted, the directive implies a 58% reduction in emissions by 2003 as compared to 1980. However, the national limits agreed in the directive were the result of lengthy negotiations based around economic arguments. Thus, the amount of benefit candidate countries can gain from reduced SO_2 will depend in part on the access to and cost of cleaner fuels and technology. Nonetheless, there is scope for large improvements in the technology and fuel used by combustion plants in the candidate countries.

Reducing SO_2 and NOx levels will bring a major health benefit to exposed populations. Health effects caused by exposure to high levels of SO_2 include breathing problems, respiratory illness, changes in the lung's defences, and worsening respiratory and cardiovascular disease. People with asthma or chronic lung or heart disease are the most sensitive to SO_2. Sulphur dioxide may also lead to increased mortality, especially if elevated levels of suspended particles are also present. SO_2 also causes formation of microscopic acid aerosols, which have serious health implications. Very high levels of SO_2 combined with a particular weather pattern caused the "London Smog" of 1952 to which over 4,000 deaths were attributed. The majority of these were amongst the elderly and those with chronic lung and heart disease.

Specific benefits likely in candidate countries include:

- In Estonia implementation of the directive would be likely to reduce emissions from oil shale combustion plants and so lead to improvement in health conditions from settlements located within the vicinity and on the dispersion pathway.

- The two major large combustion plants in Malta are the power stations at Marsa and Delimara. The former is a major polluter since it has been in operation for a number of years and the technology is outdated. Emissions of sulphur dioxide and nitrogen oxides together with particulates have negative health impacts on the surrounding residential areas. Residents complain of asthma and other respiratory diseases especially in young children and old people.

- In Poland benefits will be connected with SO2, NOx and dust emission reduction. Locally the reduction in acid deposition will be important to protect forests and fresh waters in Silesia.

- In Turkey large-scale power production plants (Yatağan – Muğla and Afşin- Elbistan both utilizing low quality lignite as fuel) cause great health problems in these areas. Compliance with the reduced SO2, NOx and particulate matter concentrations in these old power plants as well as in the ones that are under construction and/or planned have great (health) importance for this country.

1.9.3 Non-health economic exploitation benefits

Sulphur dioxide plays a particular role in the damage of forests and crops. The gas acts through the degradation of chlorophyll (NOx also causes damage to crops). SO_2, and NOx are also the main precursors of acid rain, which contributes to the acidification of lakes and streams, accelerated corrosion of buildings and reduced visibility. Economic benefits from reduced emissions will be felt most in the agriculture, forestry and fisheries sectors.

Specific benefits likely in candidate countries include:

- There will be (further) reduced acidification of soils and direct damage to forests in the 'Black Triangle', including regions of the Czech Republic and Poland.

- In Malta positive impacts on agriculture, mineral resources, fisheries and aquaculture are expected with the implementation of this Directive.

- Current power plants in Turkey have serious negative impacts on agricultural yields since the areas where they operate are also fertile agricultural lands. Tourism, Turkey's major expanding sector is also affected negatively.

1.9.4 Ecosystem benefits

Death of forests, lakes and streams from acidification resulting from SO_2 and NOx has a major impact on the health of ecosystems and biodiversity in general. In some cases, existing production may have caused critical loads to be reached in ecosystems and much damage will be irreparable. However, the regulation of new plants by the directive will help avoid any further damage.

Specific benefits likely in candidate countries include:

- Implementation in Lithuania will ensure protection of the environment for new developments such as Butinge oil terminal.

- There will be extensive ecosystem benefits due to a reduction in acidification in North West Czech Republic and South Poland.

- In Turkey Yatağan power plant operating in the province centre of Muğla poses risks for the ecosystem in that region. Similarly, Gökova power plant (in the same region) received great resistance from the public and it is operational at the present. The emissions from these power plants are great threat to the ecosystem, which is pristine and diverse.

1.9.5 Social benefits

The knowledge that vast tracts of forests and lakes are not being destroyed will contribute to the well being of society in general and will improve the quality of life for those living in areas otherwise (or previously) affected. Quality of life will also improve for those living in smog-choked cities. Specific benefits likely in candidate countries include:

- In Malta the visual impact (and associated health implications) of the emissions from the chimneys of the Marsa power station contributes towards 'labelling' the Marsa area as a highly polluted area. Improving the overall quality of the environment area will make the area more socially acceptable. Property prices are also negatively affected in the areas.

- In Turkey people living in the vicinities of these large-scale power stations as well as domestic and international tourists will benefit by the reduction of pollution from these sources.

1.9.6 Wider economic benefits

Wider economic benefits of the directive could include industries benefiting from the sale and production of cleaner fuel and cleaner technology (with consequent losses in displaced goods). The tourism industry also stands to gain economically where improvements of lakes, forests and streams and cities add value to the industry. Specific benefits likely in candidate countries include:

- In the Czech Republic and Poland it is expected that benefits from reduced impacts of acid rain on forest and fresh water ecosystems may increase tourism in these areas.
- In Poland new desulphurisation installation will have to be built for full implementation. It gives benefits to firms, which produce equipment for this type of installation.
- In Turkey the design, installation and maintenance activities for the air emission control units (equipment/system) will help a new economic sector to develop in the regions.

2.0 QUANTITATIVE ASSESSMENT: AIR RELATED DIRECTIVES

2.1 Introduction

Table B.2 below lists the individual EU directives for which we have attempted to quantify, in physical and monetary terms (see Chapter 3), the environmental benefits that would result from the thirteen candidate countries adopting these Directives. The table indicates the pollutants that are considered in each Directive. Those indicators marked in bold show which pollutants we have been able to include in our adopted methodology.

Table B.2: EU Air Quality Directives Amenable to Monetisation

	SO2	NOx	Particulates	VOCs	CO2	CO	Heavy metals	Dioxines	Furans	Halogens	Ozone	CH4
Air Quality - Relevant Directives												
Large Combustion Plants	**x**	**x**	**x**									
IPPC Directive	**x**	**x**	**x**		**x**	**x**	x			x		
Emissions from Mobile Sources	**x**	**x**	**x**		**x**	**x**	x					
Air Quality Framework + Daughter Directives for SO2, NOx and Particulates	**x**	**x**	**x**									
VOC Emissions: Storage & Transport of Petrol				**x**								
VOC-Solvents Directive				**x**								
Tropospheric Ozone Pollution											**x**	

As agreed with the European Commission, we have adopted an analytical approach that allows us to estimate the aggregate benefits of candidate countries implementing these Directives by "bundling" the directives together in the first instance. The benefits of implementing individual Directives are therefore not identified directly - though an indication of the relative importance of the different directives is given below. One reason for this bundling is that benefits from different directives cannot be separated. For instance, a SO_2 reduction due to the IPPC directive leads to reduction in SO_2 concentration and so helps towards fulfilling the limits in the first daughter directive. Another, more practical, reason centres on data availability and resources available to the project team; little research was publicly available on the quantification of the effects of implementing individual EU directives. Nevertheless, when discussing the results of our analysis we put forward some suggestions for the relative importance of individual directives in accounting for total impacts.

The four categories of pollution impacts that we quantify are:

- Premature deaths avoided (mortality).

- Illness avoided (morbidity) – e.g. bronchitis[4], asthma.
- Crop damage avoided.
- Material damage avoided.

One reason why our estimates of environmental benefits are likely to be under-estimates of the true benefits of compliance with EU directives is that we are not presently able to quantify the benefits associated with the following impacts avoided:

- Impacts on ecosystems.
- Change in biodiversity.
- Potential effects of chronic exposure to ozone.
- Impacts on cultural monuments.
- Material soiling.
- Direct and indirect economic effects of change in forest productivity, and fishery performance.

Nevertheless, we would suggest that those impacts that we can quantify are likely to represent a significant - and majority - share of the total impacts in welfare (monetary) terms.

2.2 Methodology – The Impact Pathway Approach

Within the current project, the “impact pathway approach”, developed within the ExternE project series ‘External Costs of Energy,’ has been used to quantify the benefits from emission reductions within the European Union candidate countries (European Commission 1995, European Commission 1999, European Commission 2000b).

Impact pathway assessment is a bottom-up-approach in which environmental benefits and costs are estimated by following - as far as possible - the ‘impact pathway’ from source emissions through air quality changes to physical impacts, before being expressed in monetary benefits and costs. The ECOSENSE model, an integrated software tool for environmental impact pathway assessment developed within the ExternE projects, has been used to make the benefit estimations. ECOSENSE uses harmonised air quality and impact assessment models together with a database containing the relevant input data for the whole of Europe.

Within ExternE, the ECOSENSE model was originally used to estimate external costs from individual power plants. The ‘multi-source’ version that was used in the current project is a modified version, which supports the usage of more complex emission scenarios. For further information on this version of the model, see European Commission (1998). Two emission scenarios are needed for each calculation, the reference - or baseline - scenario and the case

[4] Benefits include the benefit to the individual of not incurring the illness, and also benefits of reduce hospitalisation days and reduced activity days.

scenario. In Annex 1, the models and data used for the benefit estimations in the current project are described in more detail.

2.3 Emission Reduction Scenarios

The calculation of the emissions reductions as a consequence of the full implementation of the air-pollution related acquis are outlined for different groups of pollutants.

2.3.1 Pollutants: NO_X, SO_2, NH_3, NMVOC

Rationale

In this study we have used a baseline for emissions for these gaseous pollutants and two scenarios: one based on the Gothenburg Protocol (UN ECE 1999), and the other based on more stringent emissions reductions, based the hypothetical maximum technically feasible emission reductions (Amann et al. 2000). The non-compliance baseline and emissions under the scenarios have been calculated building on published data that represent pollutant emissions without emission ceilings, and with emission ceilings that the countries are obliged to meet by the year 2010.

The UNECE Gothenburg Protocol, signed in December 1999, is recognised by the EU as being closely related to the emission reductions aimed for under existing EU directives. In June 2000 the EU Environment Ministers agreed on emission ceilings for four major pollutants, SO_2, NO_X, NH_3, and NMVOC (European Commission 2000a), as signed in the Gothenburg protocol, and these form the one base for emissions scenarios of the current study. It is understood, however, that the emissions ceilings underestimate of the actual needs for full compliance, notably in light of the expected developments (stricter emissions standards) of the Large Combustion Plant Directive and this is therefore taken as the lower emissions reduction scenario. There is no evidence available to the project team that would suggest an alternative scenario that could be more appropriate.

If, as expected, the Large Combustion Plant Directive amendments continue to become increasingly restrictive, the standards for pollutants under the Gothenburg Protocol will not - in reality - be stringent enough to fully represent the benefits that compliance with EU legislation would confer. Therefore, in addition a sensitivity analysis has been undertaken by applying hypothetical maximum technically feasible emission reductions to show the possible range for emission reductions beyond the aims of the Gothenburg Protocol. The reduction scenario “illustrates the potential of full application of the most efficient current control technologies to the entire range of emission sources” (Amann et al. 2000). We do not expect that EU legislation will become as restrictive as this in reality but recognise that - in the absence of a consistent alternative method of simulating likely EU standards - this represents a valuable upper-bound sensitivity.

Method
The eight candidate countries included in the current analysis of compliance with the Gothenburg Protocol are: Bulgaria, Czech Republic, Hungary, Latvia, Poland, Romania, Slovakia, and Slovenia. The case and reference scenarios are outlined below. The emissions from the other countries are estimated separately (see below).

Case scenarios:
Main: In countries for which emission ceilings were formulated, these are adopted in the case scenario as emissions on country levels. For the remaining countries in the model area emissions are taken from the Co-operative Programme for Monitoring and evaluation of the Long Range Transmission of Air Pollutants (EMEP) which provides emission projections for 2010 (Vestreng and Støren 2000) which implicitly include the meeting of requirements of the Protocol. Data published by EMEP are directly reported by the countries or estimated by EMEP on the base of public sources. The emission reductions for each of the eight countries are presented in Table B.5[5].

Sensitivity: A sensitivity analysis assuming a hypothetical maximum technically feasible reduction in each of the eight countries was carried out. The emissions applied for this purpose instead of the emission reductions due to compliance with the Gothenburg Protocol respectively are listed in Table B.6.

Reference scenario: Emission projections that do not include compliance with the emission ceilings are derived from earlier projections reported by EMEP (Mylona 1999). These 2010 emission projections are used as non-compliance estimates for the reference scenarios.

For Lithuania, Estonia, Malta Cyprus and Turkey we assume reductions of 10% and 50% from the projected reference emission levels. These assumptions are made for these five countries either because they are non-signatories to the Gothenburg Protocol, (Estonia, Malta Cyprus and Turkey), or because the Protocol does not imply any reduction from existing levels (Lithuania)[6]. These percentage reductions approximate well to the scale of the reductions required of the other candidate countries that are signatories to the Gothenburg Protocol, and the maximum feasible reductions scenario, respectively.

For these countries, to estimate domestic benefits from domestic reductions we apply unit values (Euro/tonne of pollutant) - adjusted for purchasing power parity - which themselves have been derived from previous ECOSENSE modelling work in the EU and are therefore, transfer values. We estimate the trans-boundary impacts in Turkey and Cyprus by scaling the domestic impacts against the trans-boundary impacts, using the mean scaling ratios that

[5] Where possible all emissions given originally at country levels are geographically distributed in more detail by following the CORINAIR 1990/1994 and EMEP 1998 emission structure (European Environment Agency2000, McInnes 1996, Vestreng 2000, Vestreng and Støren 2000).
[6] We suggest that - apart from Cyprus and Turkey, where the lack of EMEP-scale receptor data precludes ECOSENSE modelling - these countries could be included in an ECOSENSE model run alongside the other countries considered by the Gothenburg Protocol, depending on agreement with the European Commission on the precise level of reductions to be assumed.

derive from the results of those eight countries that are modelled by EcoSense. This exercise in benefit transfer clearly reduces the robustness of the benefit results for these countries since the density and distribution of pollution receptors in these countries are not recognised. The scaling is also crude but serves to give a first approximate to the type of trans-boundary benefits we might expect from the emission reductions.

Table B.5: 2010 Emissions in the Candidate countries used for the current study.

Country	Emissions for the Case Scenario Compliance with Emission Ceilings				Emissions for the Reference Scenarios without Emission Ceilings			
	NH_3 [kt]	NMVOC [kt]	NO_X [kt]	SO_2 [kt]	NH_3 [kt]	NMVOC [kt]	NO_X [kt]	SO_2 [kt]
Bulgaria	108	185	266	856	126	192	290	1127
Czech Republic	101	220	286	283	156	435	351	376
Hungary	90	137	198	550	150	145	198	653
Latvia	44	136	84	107	44	204	84	157
Poland	468	800	879	1397	508	954	879	3210
Romania	210	523	437	918	300	616	546	1311
Slovakia	39	140	130	110	62	149	225	210
Slovenia	20	40	45	27	27	40	45	37

Table B.6: Emissions: Scenario - hypothetical maximum technically feasible emission reductions (Amann et al. 2000).

Country	Emissions for the Case Scenario Compliance with Emission Ceilings			
	NH_3 [kt]	NMVOC [kt]	NO_X [kt]	SO_2 [kt]
Bulgaria	86	37	61	130
Czech Republic	72	102	78	100
Hungary	73	50	50	186
Latvia	19	11	23	17
Poland	367	284	266	365
Romania	206	126	100	92
Slovakia	30	57	42	68
Slovenia	12	12	8	10

Table B.7: Other emissions levels assumed for 2010

Country	NH_3 [kt]	NMVOC [kt]	NO_X [kt]	SO_2 [kt]
Lithuania – non compliance	84	92	110	145
10% emission reduction	76	81	99	130
50% emission reduction	42	46	55	72
Estonia – non compliance	29	88	68	251
10% emission reduction	26	79	61	226
50% emission reduction	15	77	34	126
Malta – non compliance	15	29	26	96
10% emission reduction	14	26	24	86
50% emission reduction	8	14	13	48
Turkey – non compliance	321	955	958	354
10% emission reduction	289	860	862	319
50% emission reduction	161	478	479	177
Cyprus – non compliance	4	21	21	43
10% emission reduction	3.6	19	19	39
50% emission reduction	2	11	11	22

Table B.8 Total emission levels in the reference and case scenarios [kt]

	NH_3	NMVOC	NO_X	SO_2
Reference	1826	3920	3801	7970
Lower case*	1489	3246	3390	5048
Upper case	1093	1305	1220	1413

** Lower benefit case, hence emissions are higher than in the upper benefits case.*

2.3.2 Pollutant - PM_{10}

Rationale

We have made an approximation of the effects of compliance with EU directives on PM_{10} emissions by assuming a range of reductions of 50% and 90% from those emission levels projected for the pollutant. Our knowledge of the rate of change in technical improvements that are likely to result from the implementation of relevant EU directives suggests that 50% is a most probable reduction level, with 90% as an upper bound. This is supported by the fact that the size of difference in emission factors that have been estimated for a number of fuels used in the cleanest power and industrial combustion plants in EU countries and the average plants in a number of candidate countries (TNO 1997) has this range.

Method

Reference scenario: Current estimated PM_{10} emissions were derived from the work undertaken by TNO, (1997), extrapolating on a pro-rata basis using energy consumption levels and GDP levels relative to Poland (the largest consumer) where country-specific data was not available.

The PM10 estimates for 2010 and 2020 were then made by applying data from the energy balance projections made for the candidate countries in the PRIMES project for the European Commission (NTUA, 1999). .

Case scenario: Compliance with the EU directives was simulated by assuming 50% and 90% emission reductions from this business-as-usual scenario. The PM_{10} emissions in 2010 used as the business as usual scenario and the case scenarios are given in Table B.8.

Table B.9: PM_{10} emissions: reference and the 50% and 90% reductions assumed

Country	Year 2010 (t) (ref)	Year 2010 (t) (50%)	Year 2010 (t) (90%)
Bulgaria	140930	70465	14093
Cyprus	61246	30623	6124
Czech Republic	360180	180090	36018
Estonia	56698	28349	5669
Hungary	109700	54850	10970
Latvia	41999	21000	4200
Lithuania	92397	46199	9240
Malta	31415	15708	3142
Poland	1042620	521310	104262
Romania	223750	111875	22375
Slovakia	161820	80910	16182
Slovenia	61948	30974	6194
Turkey	1316425	658213	131643
Total	**3701128**	**1850566**	**370112**

All candidate countries, apart from Turkey and Cyprus, where the receptor databases are not sufficiently well developed, were modelled within EcoSense. For Turkey and Cyprus, the unit value for $PM_{2.5}$ that has been derived from the ExternE Core/Transport project.

Pollutants - CO and CO_2

Rationale

In the absence of empirical evidence on which to recommend particular emission reductions for CO we have assumed a range of reductions from 10% - 90% from business-as-usual levels. For CO_2 we assume reductions of between 10% and 50%. These assumptions reflect our "best guess" as to the likely effects of the EU air quality-related Directives, taking into account current technological feasibility.

Method

Reference scenarios: Business as usual emissions for CO were estimated by projecting the 1998 (or most recent year) levels reported by EMEP (Mylona 1999) by the predicted GDP growth rates given in the PRIMES work (NTUA, 2000). Business as usual emissions for CO_2 were taken directly from the emission growth rates given in PRIMES, applied to EMEP data (Vestreng and Støren 2000).

Case scenarios: The reductions of 10% and 50% for CO_2, and 10% and 90% for CO were applied to the reference scenarios for the two pollutants. The reference and case scenario reductions for all countries are presented in Table B.10.

Table B.10 Emission levels assumed for CO and CO_2 analysis

Country	CO Base (Mt)	CO 10% redn. (Mt)	CO 90% redn. (Mt)	CO_2 Base (Mt)	CO_2 10% redn. (Mt)	CO_2 50% redn. (Mt)
Bulgaria	1616.1	1454.5	161.6	75.5	68	37.8
Cyprus	322.3	290.1	32.2	8.6	7.7	4.3
CR	1735.6	1562	173.6	153.8	138.5	76.9
Estonia	744.3	669.9	74.4	25.4	22.9	12.7
Hungary	1701.9	1531.7	170.2	83.4	75.1	41.7
Latvia	866.6	779.9	86.7	10.7	9.6	5.3
Lithuania	951.7	856.5	95.2	25.4	22.9	12.7
Malta	169.1	152.2	16.9	4.3	3.9	2.2
Poland	12494	11244.6	1249.4	380.2	342	190.1
Romania	4696.6	4226.9	469.7	135.4	121.9	67.7
Slovakia	778.2	700.4	77.8	53.9	48.5	27
Slovenia	176.6	158.9	17.7	22.8	18.2	11.4
Turkey	1674.7	1507.2	167.5	238.5	214.6	119.3
Total	**27927.7**	**25134.8**	**2792.9**	**1217.9**	**1093.8**	**609.1**

2.4 Extent of Benefits

The mortality impacts of the pollution emission reductions assumed above are shown for each country in Table B.10 below for 2010 – the year in which it is assumed compliance with EU directives is achieved. For the eight candidate countries where the emission reductions assumed conform to the Gothenburg Protocol ceilings, the benefits of these reductions in EU15 countries – due to reductions in trans-boundary pollution - are also given.

Morbidity impacts are of a disparate nature and so cannot be expressed as a common unit. However, for illustration, the morbidity impacts are presented - in Table B.11 - as equivalent number of cases of chronic bronchitis avoided.

Units for materials and crop damages are not as readily meaningful and we cannot present these here. However, in the case of materials, the impact being quantified is the premature ageing of various building materials exposed to SO2 deposition from acidification. Thus, in our context, the whole exposed material surface area of an impacted that is exposed to SO_2 will age at a slower rate than if the directives were not to be implemented. For illustration, however, we can estimate using conversions, that 2,856,000 m^2 less of the building surface area in the Czech Republic will need maintenance in 2010 as a result of the implementation of the EU directives.

Crop damage is measured primarily by the change in yield that results from the change in pollutant concentrations in the air. Thus, with a knowledge of the geographical distribution of crop plantations within a country, the acreage of a given crop affected by a change in pollutant concentration can be estimated and the percentage yield change can be derived. By way of illustration, a lowering of the ambient concentration of SO_2 as a result of Directive implementation may result in a 5% increase in yield of wheat in Bulgaria in 2010.

Table B.11: Physical premature mortality impacts avoided in year 2010

	Lower reduction scenario (Gothenburg Protocol/10% redn Prot. Pollutants, 50% PM10 redn).	**Upper reduction scenario** (Maximum Feasible redn/50% Protocol pollutants, 90% PM10 redn).
Bulgaria	357	1163
Cyprus	64	126
Czech Republic	996	2216
Estonia	136	635
Hungary	998	2704
Latvia	171	443
Lithuania	101	225
Malta	11	41
Poland	7115	14344
Romania	2423	7199
Slovakia	714	1653
Slovenia	93	233
Turkey	1820	3468
Total	**14999**	**34450**

Table B.11 above, showing the number of premature deaths avoided from emission reductions in the candidate countries in the upper and lower sets of emission reduction assumptions. The numbers are for the premature deaths that would be avoided in 2010 - the first year in which full implementation of the EU directives is assumed in the candidate countries. Note that the numbers include those premature deaths avoided that result from reduced emissions in other candidate countries but some of whose benefits, as a result of trans-boundary effects, occur in other countries. The numbers therefore assume that all candidate countries implement the air-related Directives by 2010.

Pollutants that are considered include the gaseous pollutants, NMVOC, NH_3, SO_2 and NOx, together with $PM_{10.}$ The "lower" set of reductions, in the left - hand column, assume for the gaseous pollutants, emission reductions equal to those required under the Gothenburg Protocol, or, if those are not appropriate, a 10% reduction from baseline levels (as described in the section above). For PM_{10}, the emission reduction of 50% from baseline levels is assumed. The "higher" set of reductions assumes for the gaseous pollutants reductions to the level of the "maximum technologically feasible " reductions, currently defined by IIASA, or a 50% reduction from baseline emission levels. PM_{10} emission reductions of 90% are assumed for the higher bound reduction set. The mortality effects of CO and CO2 are insignificant and are not included here. Note that the rationale for these lower and upper bounds are set out in the methodological section above.

The results[7] show that a total of approximately 15,000 premature deaths are avoided when the emission reductions defined in the lower bound are implemented and 34,450 premature deaths are avoided in the higher bound emission reduction scenario. The country with the highest reductions is Poland, which has 7,115 and 14,344 premature deaths avoided under the lower and upper bound scenarios respectively. Romania and Turkey are the countries with the highest number of premature deaths avoided after Poland, with 2,423 and 1,820 respectively, in the lower bound scenario.

The morbidity benefits for the lower and higher bound emission reduction scenarios are expressed in terms of the equivalent number of cases of chronic bronchitis avoided in the country in 2010 - the first year of full compliance with the EU directives assumed. The equivalence between cases of chronic bronchitis and other health conditions is reached simply by dividing the total monetary value of morbidity benefits by the value of one case of chronic bronchitis avoided to give the number of cases of chronic bronchitis-equivalents. The total number of case - equivalents for the lower and upper scenarios are over 42,700 and 175,000 respectively. In this case, the highest number of cases avoided is in Turkey, which has nearly 27,000 and 135,000 respectively. The next largest are Poland and Romania. The difference in the countries that benefit most - in terms of cases avoided - between morbidity and mortality is likely to be, at least in part, a result of a different mix of pollutants that

[7] The results, when compared to existing data on mortality from respiratory diseases, do not seem at odds. While data is only partial across the candidate countries, and does not distinguish from different pollution exposure, it does offer a helpful comparison. There were 2955 recorded cases of Mortality through trachea, bronchus & lung cancer in 1998 in Bulgaria, 18890 in Poland and 8100 in Romania. These are higher than both the lower and the upper estimates of avoided early mortality from respiratory diseases, though only slightly higher for the upper emissions reduction scenario.

impact on different countries. As a consequence, different health end - points - or illnesses - will result in different countries.

Table B.12: Physical Morbidity Impacts in year 2010

Morbidity impacts (equivalent number of chronic bronchitis cases avoided each year)		
	Low estimate	*High Estimate*
Bulgaria	437	1402
Cyprus	99	174
Czech Republic	1528	3305
Estonia	170	527
Hungary	1589	5218
Latvia	208	1859
Lithuania	1061	1546
Malta	21	37
Poland	5667	10137
Romania	2493	6072
Slovakia	1304	8154
Slovenia	156	1417
Turkey	26970	134880
Total	**41703**	**174728**

3.0 MONETARY VALUATION: REDUCED AIR POLLUTION

3.1 Benefits upon full compliance

The monetary estimates of the benefits resulting from the air pollution emission reductions assumed above across the thirteen countries are presented in summary form in Tables B13 and Figure B1. All values presented are in million current prices, and relate to the year 2010 - the first year of assumed full implementation. A description and analysis of these results is given in this section. The values here look at the benefits to the candidate countries. Additional benefits accrue to the EU, and to third countries, and the relationship between domestic action and foreign benefit is presented in section 2.6.

The results in Table B12 show that the total benefits to the thirteen candidate countries lie between 7,700 million Euro and 44,000 million Euro each year following full implementation of the EU directives in these countries, with the lower value being a best conservative estimate. When considering the period up to 2020, with full implementation by 2010, the total benefits amount to between 75,000 and 430,000 billion EUR. These benefits are benefits to the candidate countries of all candidate countries fully implementing the directives.

The values in the Table B.13 presents the lower and upper estimates – the lower estimate is based on the lower emission reduction scenario and lower mortality values (and lower estimate of other benefits such as from reduced CO2) and the upper estimate is based on higher mortality values and higher emissions reductions scenario. Hence in these core results we do not use "central estimates" for the value of prevented mortality (see Box B1); Table E1 in the annex presents the range, including a lower-upper bound estimate and using central mortality values. It would be misleading to present a single central estimate, as this would implicitly suggest a very accurate knowledge of the relationship between pollutant, impact and monetary benefit. Hence, the lower and upper bounds reflect the bounds of confidence in the results given methodological uncertainties.

Box B1: Premature Mortality: Value of Prevented Fatality: Range of Values

The EcoSense model not only calculated the number of cases of prevented fatalities by using dose response functions, but also attributes a value to the avoided premature fatality. The value for an avoided premature mortality used the Value of a Prevented Fatality (VPF) (also known as the Value of Statistical Life, VSL) as recommended by the EU[8]

For the calculation of VSL, we use lower, central and upper estimates of the value of life in the benefits calculation to ensure that the range of benefits as presented by the lower and upper bounds gives a truer representation of uncertainty of the valuation than just using a central value.

The central value for VSL for the EU is 1MEUR, with a lower bound of 0.7MEUR and upper bound of 2.5MEUR. For the candidate countries, these values were weighed by the relative per capita purchasing price parity rations in the core analysis, and used without any weighting in a sensitivity analysis. The relative PPP is given in Table A.8 in Part A, and ranges from 0.3 in Bulgaria to 0.75 in Slovenia. In other words under the core analysis using PPP weighting (as is standard practice in benefits transfer analysis), the “core” value of life for a case of avoided early mortality would amount to 0.3MEUR in Bulgaria. In the “no weighting analysis” the value would be 1MEUR.

It is important to reiterate that the aim of the analysis is to highlight the importance of avoiding pollution caused illness and early mortality. The VSL is an indicator and not a statement of the worth of life.

The mortality impacts comprise the only impact category that can be easily aggregated from the results. It should also be stressed that mortality impacts typically comprise over 80% of the total benefits in valuations undertaken by following the described methodology, and so are by far the most significant.

See the annex for further discussion the method, including valuation of benefits of avoided illness.

Benefits from all candidate countries implementing the directives are largest for Poland - at 2.65 billion EUR/year upon full compliance with the lower estimate, and 15.4 billion EUR/year upon full compliance with the upper estimate. Turkey also stands to face significant benefits, of the order of 2.2 and 9.7 billion EUR/year for the lower and upper estimates respectively.

[8] See Annex 1 for central value results, and sections 2.5 and 2.6 for benefits value using the full range.

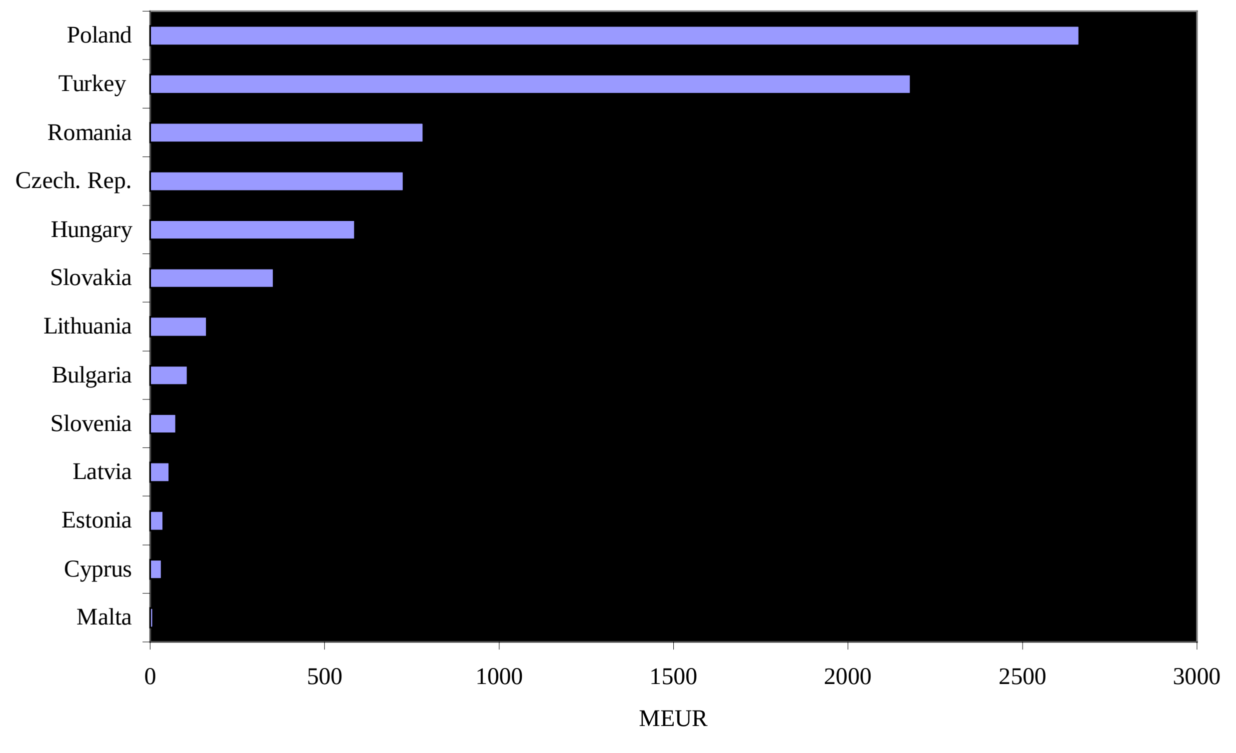
Table B13: Benefits of Full Compliance, by Candidate Country (Million €)

	Annual Benefits		Total benefits over period until 2020*	
Country	Low	High	Low	High
Bulgaria	110	1130	1070	11000
Cyprus	30	140	290	1400
Czech Republic	730	3600	7100	35050
Estonia	40	210	390	2050
Hungary	590	4100	5740	39920
Latvia	50	320	485	3120
Lithuania	160	820	1555	7980
Malta	8	40	75	390
Poland	2650	15400	25800	149930
Romania	780	5850	7590	56950
Slovakia	350	2250	3400	21900
Slovenia	70	475	680	4620
Turkey	2180	9700	21220	94440
All Candidate Countries	**7700**	**44000**	**75400**	**428700**

** Assuming full implementation in 2010. The analysis used a 4% discount rate.*
Note: Total may not add to the sum of the parts given rounding.
These values relate to the full benefits to the candidate countries - from both own action and as a result of other candidate countries implementing the EU directives, with the exception of Turkey for which only benefits from domestic actions are covered.

As suggested in the sections on the study methodology, above, the results are likely to under-estimate the true benefits of adopting the environmental acquis in the thirteen candidate countries. The lack of EMEP data for Turkey and Cyprus, and the uncertainty surrounding appropriate emission reductions of SO_2, NH_3, NMVOC and NO_X for Estonia, Lithuania and Malta meant that EcoSense modelled eight countries for the gaseous pollutants, and eleven countries for PM_{10}.

Figure B1: Annual Benefits to the Candidate Country upon Full Compliance of Air Directives (in MEUR)



3.2 Trans-boundary benefits

Table B13 above presented, for each country, the benefits that accrue to the country as a result of its own emission reductions and other candidate country reductions. Hence some of the benefits to the candidate country result from domestic action and others domestic benefits arise from foreign action. Table B14 and Figure B2 present the split for each candidate country – noting domestic benefit from domestic action and domestic benefit from foreign action.

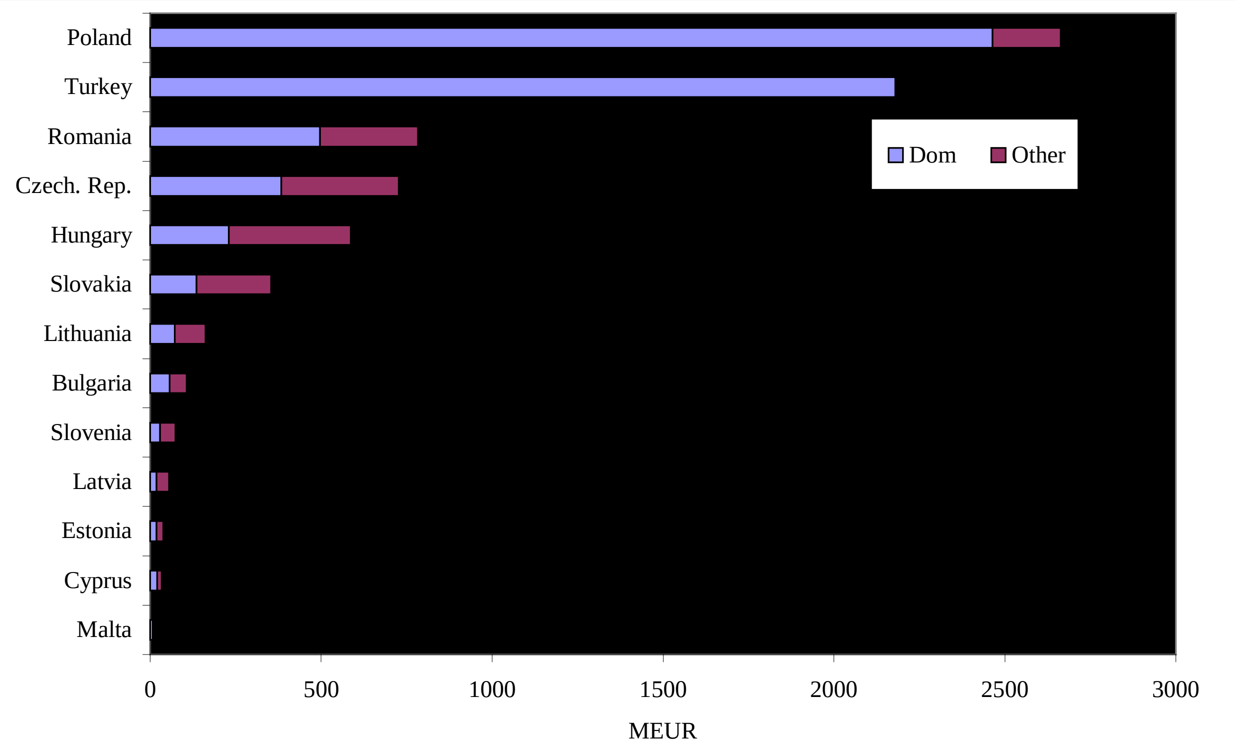
Table B14: Summary of Monetary Benefits from reduced exposure from air pollution *(in MEUR/yr upon full compliance)*

	Domestic Benefits from domestic action		Domestic benefits from foreign action		Total benefits to a country	
Benefits	**Low**	**High**	**Low**	**High**	**Low**	**High**
Bulgaria	58	520	49	610	107	1130
Cyprus	20	87	13	52	33	139
Czech. Rep.	384	2042	343	1804	727	3846
Estonia	19	111	19	101	38	212
Hungary	230	1630	357	2465	587	4095
Latvia	19	111	36	210	55	321
Lithuania	72	336	90	482	162	818
Malta	7	37	1	3	8	40
Poland	2464	11834	199	3569	2663	15403
Romania	497	3485	286	2368	783	5853
Slovakia	135	746	219	1511	354	2257
Slovenia	29	159	45	313	74	472
Turkey (1)	2180	9695	0	0	2180	9695
TOTAL (1)*	6114	30793	1657	13488	7771	44281

Note (1): given that the estimation of Turkish benefits from foreign action was very approximate, it was chosen not to include these here, as the results would significantly increase the benefits and the additional use of a very approximate (and very large) number would reduce the credibility of the total. We have therefore chosen to present a more conservative total.

The contribution of other candidate country efforts to implement the air directives to benefits in other candidate countries is very significant in many countries. Other Candidate country effort (the group as a whole), leads to half or over half of the benefits to particular countries for: Estonia, Latvia, Lithuania, Slovakia and Slovenia. This is an important result, as it underlines the benefits of cross-border and regional cooperation. Other countries benefit less from action by others. For example only around 10% of benefits in Poland arise from action in other countries.

Figure B2: Total Candidate Country Benefits – Benefits from Domestic Action and Benefits from action by other Candidate Countries
(MEUR/year upon full compliance in 2010)



Note: Benefits to Turkey from other country action have been explicitly included given the large uncertainty in the estimate.

Transboundary benefits – including non Candidate Countries

If all benefits across all countries within the model area are considered, (i.e. including EU15, Eastern Europe and Russia), the total benefits are estimated at between 26 billion EUR and 139 billion Euro.

These totals compare with the total benefits that accrue to the individual candidate countries from their own domestic emission reduction of between 6 and 31billion Euro and highlight one of the key points of this analysis, which is that there are very significant trans-boundary benefits from reduction in air emissions to levels resulting from EU directive implementation. Total foreign benefits from domestic action (i.e. excluding domestic benefits from domestic action), amount to between 19.5 billion EUR and 108 billion EUR. The details are presented in Table B15.

Table B15: Air Pollution Benefits: Transboundary Benefits

	Domestic benefits from other CCs		Foreign benefits from domestic action						Total Foreign benefits	
	From other CCs		To other CCs		To the EU		To Other Countries		From domestic action	
	Low	High	Low	High	Low	High	Low	High	Low	High
Bulgaria	49	610	121	1393	107	1467	464	5395	692	8255
Cyprus	13	52	13	51	21	83	31	125	65	259
Czech. Rep.	343	1804	280	1930	702	4371	243	1652	1225	7953
Estonia	19	101	35	240	57	390	86	585	178	1215
Hungary	357	2465	135	1549	125	1789	266	3187	526	6525
Latvia	36	210	18	208	44	489	64	824	126	1521
Lithuania	90	482	125	579	203	941	304	1412	632	2932
Malta	1	3	6	58	9	94	14	140	29	292
Poland	199	3569	577	3310	1704	10163	1841	10556	4122	24029
Romania	286	2368	218	1922	229	2169	1290	10791	1737	14882
Slovakia	219	1511	229	1223	176	1120	336	1717	741	4060
Slovenia	45	313	10	196	26	570	15	281	51	1047
Turkey (1)	*0*	*0*	1885	6899	3036	11211	4594	16817	9515	34927
TOTAL (Central)	**1657**	**13488**	**3652**	**19558**	**6439**	**34857**	**9548**	**53482**	**19639**	**107897**

Note: Benefits to Turkey from other country action have been explicitly included given the large uncertainty in the estimate.

Table B15 presents the trans-boundary effects in a more disaggregated way. In particular, it distinguishes between the benefits that accrue from the implementation of the environmental acquis communautaire to the candidate country implementing the directives (domestic benefit from domestic action), to other candidate countries, to the EU15, and third countries (Russia, Ukraine, Belarus etc).

The total benefits that accrue countries other than the candidate countries ranges between 19.5 billion Euro and 139 billion Euro, of which the highest proportion (around 50%) goes to the “Other Countries”, which include E. Europe and Russia reflecting the fact that these countries have close proximity to a number of the candidate countries and that the prevailing wind tends to be from west to east, blowing the pollutants towards them. The EU15 countries benefit by 33%, equating to 6.5 billion Euro under the lower bound scenario.

The country specific tables (E4 to E16) in the Annex present the full countries details for each candidate country. This notes the upper and lower bounds for the scenarios, the upper and lower bounds given value of avoided early mortality, and notes also the results using a “central value for avoided mortality / prevented fatality”. As noted above, the study has used the lower and upper estimates to provide the range, and not chosen to use a “central value” as this would suggest a spurious accuracy.

The results relating to trans-boundary effects to other candidate countries only include those effects to the countries modelled, and not to the other five countries, for gaseous pollutants. For PM_{10}, the trans-boundary effects from source country to other countries (including candidate countries, EU and other countries) are also not presented. The non-modelled countries use ratios between the domestic and transboundary components, derived from the average ratios in the modelled countries. Consequently, total transboundary effects will be under-estimated.

It should also be noted that the level of robustness of results is likely to be higher for those countries that are modelled by EcoSense, than for those countries where we rely on unit values transferred from other countries. This is because the results for the non-EcoSense countries do not then take into account the density and distribution of pollution receptors (e.g. human population) in the countries being studied.

Key pollutants and key benefits

The benefits discuss above are most attributable to the reduced number of premature deaths caused as a result of air pollution. Mortality benefits account for 64% of the total benefits. Morbidity benefits account for 26% whilst reduced damage to materials and to crops account for 8% and 3% respectively.

In terms of pollutants, the gaseous pollutants (SO_2, NOx, NH3 and NMVOC) and PM_{10} can be attributed 54.4% and 45.5% respectively, leaving the fractional remainder (0.2% rounded up) to CO and CO_2 – for the lower estimate value. It should be noted that the latter category is likely to be significantly under-estimated in these results (see Box 2). Benefits from CO are under-estimated as a consequence of the lack of robust quantification of the health damages that accrue to this pollutant, though they are increasingly recognised as likely to be significant. For CO_2 many impacts remain un-quantified even though there is similarly growing awareness of the possible extent of these impacts. The importance of these two pollutants is therefore expected to grow in subsequent analysis. Similarly the effects of ozone on health has not been monetised, again given weak data. This too would be expected to be significant. Finally, the current ECOSENSE model does not yet allow dispersion modelling of particulate matters, and therefore this underestimates the total likely transboundary benefits associated with reducing particulate matter emissions.

The basis for quantification of CO effects remains weak. At present, we are sufficiently confident only of the exposure - response function for congestive heart failure. As a result of this, the estimates of impacts from CO reductions derived in this analysis are likely to significantly under-estimate the true impact benefits from the implementation of the EU air quality directives. Estimates of the unit value (Euro/tonne) for CO from an EcoSense application of this exposure-response function in EU countries within ExternE Core/Transport range between 0.05 Euro/tonne and 0.35 Euro/tonne and these are applied here.

Box B2: Result Context: CO2 benefits value

The value attributed to the reduction of CO2 emissions is based on the work on climate change in the ExternE project. This has produced unit value estimates for CO_2 ranging from 0.3 Euro/tonne to 60.1 Euro/tonne with a central value of 8.9 Euro/tonne and this range of values is used in the current application. The values cited above relate to the lower estimate.

The range of values that reflect in their range a number of assumptions including those on aggregation issues, i.e. which geographical area should be considered in the estimation of physical impacts, whether these impacts are valued at local (national) prices, world average prices or EU prices, and which discount rate should be applied to impacts up to the year, 2100. When the upper estimate is used, the importance of CO2 increased significantly. Full details of the methodology used to derive these unit values are given in European Commission (2000b).

3.3 Conclusions

The study has assessed the extent of the benefits from lower emissions for the following pollutants: particulates, sulphur dioxide (SO2), nitrogen oxides (NOx), volatile organic compounds (VOCs), carbon dioxide (CO2), carbon monoxide (CO), heavy metals and Tropospheric ozone. The lower and upper emission reduction scenarios attempt to provide a range within which the benefits from the EU candidate countries adopting the air quality related acquis may be found.

In summary, the key benefits identified are:

- It is estimated that between 43,000 and 180,000 cases of chronic bronchitis could be avoided per year through the full implementation of EU air related directives.
- Furthermore, the implementation of the air related environmental acquis should lead to between 15,000 and 34,000 fewer cases of premature death arising from lung cancer and other related respiratory diseases.

The key monetary benefits are:

- Full compliance should lead to a benefit ranging in value from 7.8 billion to 44.3 billion EUR for the thirteen candidate countries in 2010.[9]
- Total benefits to all non-candidate countries, including EU and third countries such as Russia, have been estimated to lie between 20 billion Euro and 108 billion Euro in 2010 [10].
- The gaseous pollutants comprise almost 55% of the benefits whilst PM_{10} accounts for almost 45% of the total benefits.
- Avoided early mortality is the largest source of benefit; the value attributed to avoiding early mortality amount to over 60% of the total benefits valued.

The study builds on and significantly extends previous analyses of the benefits of candidate countries compliance with EU directive standards since it includes additional countries and more pollutants, the most significant being PM_{10}. However, the results presented are still likely to be under-estimates of the true benefits of compliance with these standards. The principal reasons for this are that:

i) The benefits of reductions in some pollutants, notably CO, CO_2 and CH_4, are not fully valued since the impact-pathways are not yet defined for all end-points;

[9] This range would be between 12 billion Euro and 33 billion Euro when using the central value for a case of premature mortality avoided. Here the spread would simply represent the different emissions reductions scenarios.

[10] Where the central value for value of life is used, this range would be between 33 to 80 billion EUR.

ii) Not all countries are modelled within EcoSense so that true transboundary effects are likely to be higher than presented.

It should also be noted that uncertainty remains integral to the analysis – in other words the analysis does not try to hide the uncertainty in the estimates, on the contrary. Two examples of uncertainty include:

- The extent to which the lower and upper bounds approximate to the implementation of EU directives in the candidate countries;
- Monetary valuation of the receptor end-points, particularly premature deaths avoided;

Whilst these limitations must be acknowledged, the project team is confident that the results, if seen in the context of the uncertainties, do present very important conclusions on the scale of benefits that can accrue from the proper implementation of the directives, from which broad policy conclusions can be drawn.

It is, however, clear that this analysis could helpfully be developed further in the future – both in focus and in accuracy. Improvements could include:

- With the exception of Cyprus and part of Turkey, all countries are now fully integrated into the EcoSense model, allowing greater robustness of benefit estimation.
- Further work is ongoing in the EU on a pan-European valuation of premature deaths avoided. This could help reduce the uncertainty of this key driver of the benefits estimates.

The current modelling exercise could usefully be carried out for particular regions, countries, or areas with a country (e.g. particularly polluted area). Similarly it could be used to explore one directive of bundle of directives in more detail. And there could be a benefits assessment for funding programmes. Each of these approaches should help offer policy makers a tool to help integrate an understanding of benefits into decision-making.

ANNEXES

Annex 1: Data Tables
Annex 2: EcoSense Model

ANNEXES

Annex 1: Data Tables

Table E1: Summary of Monetary Benefits from reduced exposure from air pollution

	Domestic benefits from domestic action		Domestic benefits from other CCs		Total benefits to a country		Foreign benefits from domestic action		Total benefits from domestic actions	
Benefits	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**
Bulgaria	71 (58 - 136)	308 (278 - 519)	85 (49-141)	329 (274 - 610)	156 (107 - 277)	641 (552 - 1128)	1,033 (692 - 1787)	4,774 (3194 - 8257)	1,104 (750 - 1923)	5083 (3406 - 8805)
Cyprus	25 (20 - 45)	48 (40 - 87)	16 (13 - 26)	29 (23 - 52)	41 (33 - 71)	77 (63 - 139)	81 (65 - 130)	146 (113 - 259)	106 (85 - 175)	194 (153 - 346)
Czech. Rep.	484 (384 - 981)	1005 (797 - 2037)	349 (343 - 732)	860 (845 - 1804)	833 (727 - 1713)	1865 (1642 - 3846)	1,830 (1224 - 3166)	4,602 (3081 - 7958)	2,314 (1608 - 4147)	5607 (3822 - 9878)
Estonia	23 (19 - 44)	59 (49 - 111)	22 (19 - 41)	57 (48 - 101)	45 (38 - 85)	116 (97 - 212)	211 (178 - 389)	665 (568 - 1216)	234 (197 - 433)	723 (616 - 1326)
Hungary	291 (230 - 600)	812 (649 - 1627)	446 (357 - 893)	1,231 (985 - 2465)	737 (587 - 1493)	2043 (1634 - 4092)	787 (526 - 1361)	3,775 (2523 - 6525)	1,078 (756 - 1961)	4587 (3175 - 8155)
Latvia	24 (19 - 48)	54 (43 - 110)	45 (36 - 90)	105 (84 - 210)	69 (55 - 138)	159 (127 - 320)	188 (126 - 326)	880 (589 - 1522)	212 (145 - 374)	934 (632 - 1632)
Lithuania	89 (72 - 172)	175 (143 - 335)	109 (90 - 202)	260 (215 - 482)	198 (162 - 374)	435 (358 - 817)	761 (632 - 1393)	1,621 (1345 - 2933)	850 (713 - 1565)	1796 (1489 - 3269)
Malta	8 (7 - 15)	20 (17 - 37)	0.8 (1 - 3)	3 (2 - 5)	9 (8 - 16)	23 (20 - 40)	32 (29 - 65)	162 (146 - 292)	40 (36 - 80)	182 (163 - 329)
Poland	3,120 (2464 - 6401)	5,885 (4697 - 11830)	657 (199 - 1271)	1,845 (559 - 3569)	3,777 (2663 - 7672)	13620 (5260 - 15403)	6,160 (4121 - 10657)	13,894 (9293 - 24030)	9,280 (6585 - 17058)	19779 (13994 - 35864)
Romania	622 (497 - 1245)	1752 (1405 - 3485)	356 (286 - 705)	1,196 (961 - 2368)	978 (783 - 1950)	2948 (2366 - 5853)	2,597 (1737 - 4493)	8,606 (5755 - 14882)	3,219 (2234 - 5738)	10359 (7160 - 18367)
Slovakia	170 (135 - 347)	369 (295 - 746)	277 (219 - 565)	741 (586 - 1511)	447 (354 - 912)	1110 (879 - 2255)	1,108 (741 - 1917)	2,348 (1572 - 4061)	1,278 (876 - 2264)	2717 (1865 - 4805)
Slovenia	36 (29 - 73)	77 (61 - 158)	57 (45 - 118)	151 (119 - 313)	93 (74 - 191)	228 (180 - 471)	76 (51 - 131)	606 (406 - 1047)	112 (80 - 204)	683 (467 - 1205)
Turkey	2,610 (2180 - 4752)	5,231 (4444 - 9688)	2,154 (1900 - 3409)	4,392 (3880 - 6953)	4,764 (4080 - 8161)	9623 (8324 - 16641)	10,822 (9542 - 17123)	22,071 (19496 - 34934)	13,432 (11722 - 2187	27302 (23940 - 44622)
TOTAL (Central)	**7,573**	**15,795**	**4,574**	**11,199**	**12,147**	**32,888**	**25,686**	**64,150**	**33,259**	**79,946**

Table E2: Air Pollution Benefits: Transboundary Benefits

	Domestic benefits From other CCs		Foreign benefits from domestic action To other CCs		To EU		To Other Countries		Total	
	Low	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**
Bulgaria	85	329	181	805	159	848	693	3,119	1,033	4,774
	(49-141)	(274 - 610)	(121 - 313)	(539 - 1393)	(107 - 275)	(567 - 1467)	(464 - 1199)	(2086 - 5395)	(692 - 1787)	(3194 - 8257)
Cyprus	16	29	16	29	26	47	39	70	81	146
	(13 - 26)	(23 - 52)	(13 - 26)	(22 - 51)	(21 - 42)	(36 - 83)	(31 - 62)	(55 - 125)	(65 - 130)	(113 - 259)
Czech. Rep.	349	860	418	1,116	1,049	2,526	363	955	1,830	4,602
	(343 - 732)	(845 - 1804)	(280 - 723)	(746 - 1930)	(702 - 1814)	(1690 - 4371)	(243 - 629)	(639 - 1652)	(1224 - 3166)	(3081 - 7958)
Estonia	22	57	42	131	68	213	101	320	211	665
	(19 - 41)	(48 - 101)	(35 - 77)	(112 - 240)	(57 - 125)	(182 - 390)	(86 - 187)	(273 - 585)	(178 - 389)	(568 - 1216)
Hungary	446	1,231	202	895	187	1,034	398	1,842	787	3,775
	(357 - 893)	(985 - 2465)	(135 - 350)	(599 - 1549)	(125 - 324)	(692 - 1789)	(266 - 688)	(1233 - 3187)	(526 - 1361)	(2525 - 6528)
Latvia	45	105	27	120	66	283	95	476	188	880
	(36 - 90)	(84 - 210)	(18 - 47)	(80 - 208)	(44 - 115)	(189 - 489)	(64 - 164)	(319 - 824)	(126 - 326)	(589 - 1522)
Lithuania	109	260	150	320	244	520	367	780	761	1,621
	(90 - 202)	(215 - 482)	(125 - 276)	(266 - 579)	(203 - 447)	(432 - 941)	(304 - 671)	(647 - 1412)	(632 - 1393)	(1346 - 2934)
Malta	0.8	3	6	32	10	52	16	78	32	162
	(1 - 3)	(2 - 5)	(6 - 13)	(29 - 58)	(9 - 21)	(47 - 94)	(14 - 31)	(70 - 140)	(29 - 65)	(146 - 292)
Poland	657	1,845	862	1,914	2,547	5,874	2,751	6,102	6,160	13,894
	(199 - 1271)	(559 - 3569)	(577 - 1491)	(1280 - 3310)	(1704 - 4406)	(3930 - 10163)	(1841 - 4760)	(4082 - 10556)	(4121 - 10657)	(9297 - 24034)
Romania	356	1,196	326	1,111	342	1,254	1,928	6,238	2,597	8,606
	(286 - 705)	(961 - 2368)	(218 - 565)	(743 - 1922)	(229 - 592)	(839 - 2169)	(1290 - 3336)	(4173 - 10791)	(1737 - 4493)	(5759 - 14886)
Slovakia	277	741	342	707	264	647	502	992	1,108	2,348
	(219 - 565)	(586 - 1511)	(229 - 592)	(473 - 1223)	(176 - 456)	(433 - 1120)	(336 - 869)	(664 - 1717)	(741 - 1917)	(1572 - 4061)
Slovenia	57	151	14	113	38	329	23	162	76	606
	(45 - 118)	(119 - 313)	(10 - 25)	(76 - 196)	(26 - 66)	(220 - 570)	(15 - 40)	(109 - 281)	(51 - 131)	(406 - 1047)
Turkey	2,154	4,392	2,138	4,358	3,474	7,082	5,210	10,634	10,822	22,064
	(1900 - 3409)	(3880 - 6953)	(1885 - 3382)	(3862 - 6899)	(3063 - 5496)	(6256 - 11211)	(4594 - 8245)	(9383 - 16817)	(9542 - 17123)	(19489 - 34927)
TOTAL (Central)	**4,574**	**11,199**	**4,724**	**11,651**	**8,474**	**20,709**	**12,486**	**31,768**	**25,686**	**64,143**

Table E3: Total Benefits disaggregated by receptor and pollutant				
	Total Benefits of CC action on all countries			
	Euro (million/annum)			
	Low	**Upper**	% of total	
Total	**33259**	**79946**		
Mortality benefits	21346	51311	64%	
Morbidity benefits	8508	20450	26%	
Crop benefits	844	2028	3%	
Material benefits	2561	6156	8%	
	Low	**Upper**	% of total	
Total	**33259**	**79946**		
SO2, NOX, NH3, NMVOC	18078	43454	54.4%	
PM10	15116	36336	45.5%	
CO+CO2	65	156	0.2%	

Table E4

Annual Compliance Benefits - BULGARIA

	Lower Bound (Million Euro)				Upper Bound (Million Euro)			
Domestic Receptor benefits from domestic reductions	SO2, NOX, NH3, NMVOC	PM10	CO+CO2	**Total**	SO2, NOX, NH3, NMVOC	PM10	CO+CO2	**Total**
Mortality benefits (? million / year)	27 (19 - 67)	16 (11-40)		**43 (30 - 107)**	111 (78 - 278)	29 (20 - 71)		**138 (98 - 349)**
Morbidity benefits (? million / year)	5	7		**12**	23	12		**36**
Crop benefits (? million / year)	7			**7**	103			**103**
Material benefits (? million / year)	9			**9**	31			**31**
Total domestic benefits from dom. Action (A)	48 (40-89)	23 (18 - 47)		**71 (58 - 136)**	268 (245 - 435)	41 (32 - 83)		**308 (278 - 519)**
Benefits from redns. in other Cand. Countries (B)	85 (49-141)			**85 (49-141)**	329 (274 - 610)			**329 (274 - 610)**
Total domestic benefits from all reductions (A+B)	133 (89-230)	23 (18 - 47)		**156 (107 - 277)**	598 (520 - 1045)	41 (32 - 83)		**639 (552 - 1128)**
Transboundary benefits from domestic action								
Other Cand. Countries	181 (121 - 313)			**181 (121 - 313)**	805 (539 - 1393)			**805 (539 - 1393)**
EU	159 (107 - 275)			**159 (107 - 275)**	848 (567 - 1467)			**848 (567 - 1467)**
Other Countries	693 (464 - 1199)			**693 (464 - 1199)**	3119 (2086 - 5395)			**3119 (2086 - 5395**
Transboundary benefits total (C)	1033 (692 - 1787)		0.004	**1033 (692 - 1787)**	4772 (3192 - 8255)		2.4	**4774 (3194 - 8257)**
Total benefits from domestic action (A+C)	1081 (732 - 1876)	23 (18 - 47)	0.004	**1104 (750 - 1923)**	5040 (3372 - 8720)	41 (32 - 83)	2.4	**5083 (3406 - 8805)**

Table E5

Annual Compliance Benefits - CYPRUS

	Lower Bound (Million Euro)				Upper Bound (Million Euro)			
Domestic Receptor benefits from domestic reductions	SO2, NOX, NH3, NMVOC	PM10	CO+CO2	**Total**	SO2, NOX, NH3, NMVOC	PM10	CO+CO2	**Total**
Mortality benefits (? million / year)	3 (2 - 6)	11 (7 - 28)		**14 (9 - 34)**	5 (3 - 12)	21 (15 - 53)		**26 (18 - 65)**
Morbidity benefits (? million / year)	2	7		**9**	3	14		**17**
Crop benefits (? million / year)	0.2	1		**1**	0.4	2		**2**
Material benefits (? million / year)	0.2	1		**1**	0.4	2		**2**
Total domestic benefits from dom. Action (A)	5 (4 - 8)	20 (16 - 37)		**25 (20 - 45)**	9 (7 - 16)	39 (33 - 71)		**48 (40 - 87)**
Benefits from redns. in other Cand. Countries (B)	16 (13 - 26)			**16 (13 - 26)**	29 (23 - 52)			**29 (23 - 52)**
Total domestic benefits from all reductions (A+B)	21 (17 - 34)	20 (16 - 37)		**41 (33 - 71)**	38 (30 - 68)	39 (33 - 71)		**77 (63 - 139)**
Transboundary benefits from domestic action								
Other Cand. Countries	16 (13 - 26)			**16 (13 - 26)**	29 (22 - 51)			**29 (22 - 51)**
EU	26 (21 - 42)			**26 (21 - 42)**	47 (36 - 83)			**47 (36 - 83)**
Other Countries	39 (31 - 62)			**39 (31 - 62)**	70 (55 - 125)			**70 (55 - 125)**
Transboundary benefits total (C)	81 (65 - 130)		0.001	**81 (65 - 130)**	146 (113 - 259)		0.3	**146 (113 - 259)**
Total benefits from domestic action (A+C)	86 (69 - 138)	20 (16 - 37)	0.001	**106 (85 - 175)**	155 (120 - 275)	39 (33 - 71)	0.3	**194 (153 - 346)**

Table E6

Annual Compliance Benefits - CZECH REPUBLIC

	Lower Bound (Million Euro)				Upper Bound (Million Euro)			
Domestic Receptor benefits from domestic reductions	SO2, NOX, NH3, NMVOC	PM10	CO+CO2	**Total**	SO2, NOX, NH3, NMVOC	PM10	CO+CO2	**Total**
Mortality benefits (? million / year)	107 (75 - 269)	224 (157 - 560)		**331 (232 - 829)**	289 (202 - 722)	403 (282 - 1008)		**692 (484 - 1730)**
Morbidity benefits (? million / year)	26	97		**123**	73	174		**247**
Crop benefits (? million / year)	16			**16**	32			**32**
Material benefits (? million / year)	13			**13**	33			**33**
Total domestic benefits from dom. Action (A)	163 (131 - 324)	321 (253 - 657)		**484 (384 - 981)**	428 (341 - 860)	577 (456 - 1182)		**1005 (797 - 2037)**
Benefits from redns. in other Cand. Countries (B)	349 (343 - 732)			**349 (343 - 732)**	860 (845 - 1804)			**860 (845 - 1804)**
Total domestic benefits from all reductions (A+B)	512 (474 - 1056)	321 (253 - 657)		**833 (727 - 1713)**	1288 (1186 - 2664)	577 (456 - 1182)		**1865 (1642 - 3846)**
Transboundary benefits from domestic action								
Other Cand. Countries	418 (280 - 723)			**418 (280 - 723)**	1116 (746 - 1930)			**1116 (746 - 1930)**
EU	1049 (702 - 1814)			**1049 (702 - 1814)**	2526 (1690 - 4371)			**2526 (1690 - 4371)**
Other Countries	363 (243 - 629)			**363 (243 - 629)**	955 (639 - 1652)			**955 (639 - 1652)**
Transboundary benefits total (C)	1830 (1224 - 3166)		0.01	**1830 (1224 - 3166)**	4597 (3076 - 7953)		5	**4602 (3081 - 7958)**
Total benefits from domestic action (A+C)	1993 (1355 - 3490)	321 (253 - 657)	0.01	**2314 (1608 - 4147)**	5024 (3361 - 8691)	577 (456 - 1182)	5	**5607 (3822 - 9878)**

Table E7: Summary Table: Total Annual Benefits in 2010: Estonia

Annual Compliance Benefits - ESTONIA

	Lower Bound (Million Euro)				Upper Bound (Million Euro)			
Domestic Receptor benefits from domestic reductions	SO2, NOX, NH3, NMVOC	PM10	CO+CO2	**Total**	SO2, NOX, NH3, NMVOC	PM10	CO+CO2	**Total**
Mortality benefits (? million / year)	7 (5 - 18)	7 (5 - 17)		**14 (10 - 35)**	22 (16 - 56)	12 (8 - 30)		**34 (24 - 86)**
Morbidity benefits (? million / year)	4	3		**7**	15	5		**20**
Crop benefits (? million / year)	1			**1**	2			**2**
Material benefits (? million / year)	1			**1**	2			**2**
Total domestic benefits from dom. Action (A)	13 (11 - 24)	10 (8 - 20)		**23 (19 - 44)**	41 (35 - 75)	17 (13 - 35)		**59 (49 - 111)**
Benefits from redns. in other Cand. Countries (B)	22 (19 - 41)			**22 (19 - 41)**	57 (48 - 101)			**57 (48 - 101)**
Total domestic benefits from all reductions (A+B)	35 (30 - 65)	10 (8 - 20)		**45 (38 - 85)**	98 (83 - 176)	17 (13 - 35)		**116 (97 - 212)**
Transboundary benefits from domestic action								
Other Cand. Countries	42 (35 - 77)			**42 (35 - 77)**	131 (112 - 240)			**131 (112 - 240)**
EU	68 (57 - 125)			**68 (57 - 125)**	213 (182 - 390)			**213 (182 - 390)**
Other Countries	101 (86 - 187)			**101 (86 - 187)**	320 (273 - 585)			**320 (273 - 585)**
Transboundary benefits total (C)	211 (178 - 389)		0.002	**211 (178 - 389)**	664 (567 - 1215)		1	**665 (568 - 1216)**
Total benefits from domestic action (A+C)	224 (189 - 413)	10 (8 - 20)	0.002	**234 (197 - 433)**	705 (602 - 1290)	17 (13 - 35)	1	**723 (616 - 1326)**

Table E8

Annual Compliance Benefits - HUNGARY

	Lower Bound (Million Euro)				Upper Bound (Million Euro)			
Domestic Receptor benefits from domestic reductions	SO2, NOX, NH3, NMVOC	PM10	CO+CO2	**Total**	SO2, NOX, NH3, NMVOC	PM10	CO+CO2	**Total**
Mortality benefits (? million / year)	86 (60 - 214)	120 (84 - 300)		**206 (144 - 514)**	327 (229 - 818)	216 (151 - 540)		**543 (380 - 1358)**
Morbidity benefits (? million / year)	22	52		**74**	78	93		**171**
Crop benefits (? million / year)	- 4			**- 4**	56			**56**
Material benefits (? million / year)	15			**15**	42			**42**
Total domestic benefits from dom. Action (A)	119 (94 - 248)	172 (136 - 352)		**291 (230 - 600)**	503 (405 - 994)	309 (244 - 633)		**812 (649 - 1627)**
Benefits from redns. in other Cand. Countries (B)	446 (357 - 893)			**446 (357 - 893)**	1231 (985 - 2465)			**1231 (985 - 2465)**
Total domestic benefits from all reductions (A+B)	565 (451 - 1141)	172 (136 - 352)		**737 (587 - 1493)**	1734 (1390 - 3459)	309 (244 - 633)		**2043 (1634 - 4092)**
Transboundary benefits from domestic action								
Other Cand. Countries	202 (135 - 350)			**202 (135 - 350)**	895 (599 - 1549)			**895 (599 - 1549)**
EU	187 (125 - 324)			**187 (125 - 324)**	1034 (692 - 1789)			**1034 (692 - 1789)**
Other Countries	398 (266 - 688)			**398 (266 - 688)**	1842 (1233 - 3187)			**1842 (1233 - 3187)**
Transboundary benefits total (C)	787 (526 - 1361)		0.01	**787 (526 - 1361)**	3772 (2523 - 6525)		3	**3775 (2526 - 6528)**
Total benefits from domestic action (A+C)	906 (620 - 1609)	172 (136 - 352)	0.01	**1078 (756 - 1961)**	4275 (2928 - 7519)	309 (244 - 633)	3	**4587 (3175 - 8155)**

Annual Compliance Benefits - HUNGARY

	Lower Bound (Million Euro)				Upper Bound (Million Euro)			
	SO2, NOX, NH3, NMVOC	PM10	CO+CO2	**Total**	SO2, NOX, NH3, NMVOC	PM10	CO+CO2	**Total**
Domestic Receptor benefits from domestic reductions								
Mortality benefits (? million / year)	86 (60 - 214)	120 (84 - 300)		**206 (144 - 514)**	327 (229 - 818)	216 (151 - 540)	3	**546 (383 - 1361)**
Morbidity benefits (? million / year)	22	52		**74**	78	93		**171**
Crop benefits (? million / year)	- 4		-	**4**	56			**56**
Material benefits (? million / year)	15			**15**	42			**42**
Total domestic benefits from dom. Action (A)	119 (94 - 248)	172 (136 - 352)	0.01	**291 (230 - 600)**	503 (405 - 994)	309 (244 - 633)	3	**815 (652 - 1630)**
Benefits from redns. in other Cand. Countries (B)	446 (357 - 893)			**446 (357 - 893)**	1231 (985 - 2465)			**1231 (985 - 2465)**
Total domestic benefits from all reductions (A+B)	565 (451 - 1141)	172 (136 - 352)	0.01	**737 (587 - 1493)**	1734 (1390 - 3459)	309 (244 - 633)	3	**2046 (1637 - 4095)**
Transboundary benefits from domestic action								
Other Cand. Countries	202 (135 - 350)			**202 (135 - 350)**	895 (599 - 1549)			**895 (599 - 1549)**
EU	187 (125 - 324)			**187 (125 - 324)**	1034 (692 - 1789)			**1034 (692 - 1789)**
Other Countries	398 (266 - 688)			**398 (266 - 688)**	1842 (1233 - 3187)			**1842 (1233 - 3187)**
Transboundary benefits total (C)	787 (526 - 1361)			**787 (526 - 1361)**	3772 (2523 - 6525)			**3772 (2523 - 6525)**
Total benefits from domestic action (A+C)	906 (620 - 1609)	172 (136 - 352)	0.01	**1078 (756 - 1961)**	4275 (2928 - 7519)	309 (244 - 633)	3	**4587 (3175 - 8155)**

Table E9

Annual Compliance Benefits - LATVIA

	Lower Bound (Million Euro)				Upper Bound (Million Euro)			
Domestic Receptor benefits from domestic reductions	SO2, NOX, NH3, NMVOC	PM10	CO+CO2	**Total**	SO2, NOX, NH3, NMVOC	PM10	CO+CO2	**Total**
Mortality benefits (? million / year)	4 (3 - 9)	13 (9 - 32)		**17 (12 - 41)**	14 (10 - 36)	23 (16 - 57)		**37 (26 - 93)**
Morbidity benefits (? million / year)	1	5		**6**	3	10		**13**
Crop benefits (? million / year)	0.06			**0.06**	1			**1**
Material benefits (? million / year)	1			**1**	3			**3**
Total domestic benefits from dom. Action (A)	6 (5 - 11)	18 (14 - 37)		**24 (19 - 48)**	21 (17 - 43)	33 (26 - 67)		**54 (43 - 110)**
Benefits from redns. in other Cand. Countries (B)	45 (36 - 90)			**45 (36 - 90)**	105 (84 - 210)			**105 (84 - 210)**
Total domestic benefits from all reductions (A+B)	51 (41 - 101)	18 (14 - 37)		**69 (55 - 138)**	126 (111 - 253)	33 (26 - 67)		**159 (127 - 320)**
Transboundary benefits from domestic action								
Other Cand. Countries	27 (18 - 47)			**27 (18 - 47)**	120 (80 - 208)			**120 (80 - 208)**
EU	66 (44 - 115)			**66 (44 - 115)**	283 (189 - 489)			**283 (189 - 489)**
Other Countries	95 (64 - 164)			**95 (64 - 164)**	476 (319 - 824)			**476 (319 - 824)**
Transboundary benefits total (C)	188 (126 - 326)		0	**188 (126 - 326)**	879 (588 - 1521)		1	**880 (589 - 1522)**
Total benefits from domestic action (A+C)	194 (131 - 337)	18 (14 - 37)	0	**212 (145 - 374)**	900 (605 - 1564)	33 (26 - 67)	1	**934 (632 - 1632)**

Table E10:

Annual Compliance Benefits - LITHUANIA

	Lower Bound (Million Euro)				Upper Bound (Million Euro)			
Domestic Receptor benefits from domestic reductions	SO2, NOX, NH3, NMVOC	PM10	CO+CO2	**Total**	SO2, NOX, NH3, NMVOC	PM10	CO+CO2	**Total**
Mortality benefits (? million / year)	26 (18 - 65)	29 (20 - 73)		**55 (38 - 138)**	55 (38 - 136)	52 (37 - 131)		**107 (75 - 267)**
Morbidity benefits (? million / year)	17	13		**30**	35	23		**58**
Crop benefits (? million / year)	2			**2**	5			**5**
Material benefits (? million / year)	2			**2**	5			**5**
Total domestic benefits from dom. Action (A)	47 (39 - 86)	42 (33 - 86)		**89 (72 - 172)**	100 (83 - 181)	75 (60 - 154)		**175 (143 - 335)**
Benefits from redns. in other Cand. Countries (B)	109 (90 - 202)			**109 (90 - 202)**	260 (215 - 482)			**260 (215 - 482)**
Total domestic benefits from all reductions (A+B)	156 (129 - 288)	42 (33 - 86)		**198 (162 - 374)**	360 (298 - 663)	75 (60 - 154)		**435 (358 - 817)**
Transboundary benefits from domestic action								
Other Cand. Countries	150 (125 - 276)			**150 (125 - 276)**	320 (266 - 579)			**320 (266 - 579)**
EU	244 (203 - 447)			**244 (203 - 447)**	520 (432 - 941)			**520 (432 - 941)**
Other Countries	367 (304 - 671)			**367 (304 - 671)**	780 (647 - 1412)			**780 (647 - 1412)**
Transboundary benefits total (C)	761 (632 - 1393)		0.002	**761 (632 - 1393)**	1620 (1345 - 2933)		1	**1621 (1346 - 2934)**
Total benefits from domestic action (A+C)	808 (671 - 1479)	42 (33 - 86)	0.002	**850 (713 - 1565)**	1720 (1428 - 3114)	75 (60 - 154)	1	**1796 (1489 - 3269)**

Table E11: Summary Table: Total Annual Benefits in 2010: Malta

Annual Compliance Benefits - MALTA

	Lower Bound (Million Euro)				**Upper Bound (Million Euro)**			
Domestic Receptor benefits from domestic reductions	SO2, NOX, NH3, NMVOC	PM10	CO+CO2	**Total**	SO2, NOX, NH3, NMVOC	PM10	CO+CO2	**Total**
Mortality benefits (? million / year)	1 (1 - 3)	4 (3 - 9)		**5 (4 - 12)**	5 (4 - 13)	7 (5 - 16)		**12 (9 - 29)**
Morbidity benefits (? million / year)	1	2		**3**	4	3		**7**
Crop benefits (? million / year)	0.1			**0.1**	0.4			**0.4**
Material benefits (? million / year)	0.1			**0.1**	0.4			**0.4**
Total domestic benefits from dom. Action (A)	2 (2 - 4)	6 (5 - 11)		**8 (7 - 15)**	10 (9 - 18)	10 (8 - 19)		**20 (17 - 37)**
Benefits from redns. in other Cand. Countries (B)	0.77 (0.55 - 3)			**0.77 (0.55 - 3)**	3 (2 - 5)			**3 (2 - 5)**
Total domestic benefits from all reductions (A+B)	3 (3 - 7)	6 (5 - 11)		**9 (8 - 18)**	13 (12 - 23)	10 (8 - 19)		**23 (20 - 42)**
Transboundary benefits from domestic action								
Other Cand. Countries	6 (6 - 13)			**6 (6 - 13)**	32 (29 - 58)			**32 (29 - 58)**
EU	10 (9 - 21)			**10 (9 - 21)**	52 (47 - 94)			**52 (47 - 94)**
Other Countries	16 (14 - 31)			**16 (14 - 31)**	78 (70 - 140)			**78 (70 - 140)**
Transboundary benefits total (C)	32 (29 - 65)		0.001	**32 (29 - 65)**	162 (146 - 292)		0.16	**162 (146 - 292)**
Total benefits from domestic action (A+C)	34 (31 - 69)	6 (5 - 11)	0.001	**40 (36 - 80)**	172 (155 - 310)	10 (8 - 19)	0.16	**182 (163 - 329)**

Table E12

Annual Compliance Benefits - POLAND

	Lower Bound (Million Euro)				Upper Bound (Million Euro)			
Domestic Receptor benefits from domestic reductions	SO2, NOX, NH3, NMVOC	PM10	CO+CO2	**Total**	SO2, NOX, NH3, NMVOC	PM10	CO+CO2	**Total**
Mortality benefits (? million / year)	1570 (1099 - 3925)	617 (432 - 1543)		**2187 (1531 - 5468)**	2852 (1997 - 7131)	1111 (778 - 2777)		**3963 (2776 - 9909)**
Morbidity benefits (? million / year)	274	266		**540**	581	479		**1060**
Crop benefits (? million / year)	35			**35**	274			**274**
Material benefits (? million / year)	358			**358**	588			**588**
Total domestic benefits from dom. Action (A)	2237 (1766 - 4592)	883 (698 - 1809)		**3120 (2464 - 6401)**	4295 (3440 - 8574)	1590 (1257 - 3256)		**5885 (4697 - 11830)**
Benefits from redns. in other Cand. Countries (B)	657 (199 - 1271)			**657 (199 - 1271)**	1845 (559 - 3569)			**1845 (559 - 3569)**
Total domestic benefits from all reductions (A+B)	2894 (1965 - 5863)	883 (698 - 1809)		**3777 (2663 - 7672)**	6140 (3999 - 12143)	1590 (1257 - 3256)		**13620 (5256 - 15399)**
Transboundary benefits from domestic action								
Other Cand. Countries	862 (577 - 1491)			**862 (577 - 1491)**	1914 (1280 - 3310)			**1914 (1280 - 3310)**
EU	2547 (1704 - 4406)			**2547 (1704 - 4406)**	5874 (3930 - 10163)			**5874 (3930 - 10163)**
Other Countries	2751 (1841 - 4760)			**2751 (1841 - 4760)**	6102 (4082 - 10556)			**6102 (4082 - 10556)**
Transboundary benefits total (C)	6160 (4121 - 10657)		0.03	**6160 (4121 - 10657)**	13890 (9293 - 24030)		4.4	**13894 (9297 - 24034)**
Total benefits from domestic action (A+C)	8397 (5887 - 15249)	883 (698 - 1809)	0.03	**9280 (6585 - 17058)**	18185 (12733 - 32604)	1590 (1257 - 3256)	4.4	**19779 (13994 - 35864)**

Table E13: Summary Table: Total Annual Benefits in 2010: Romania

Annual Compliance Benefits - ROMANIA

	Lower Bound (Million Euro)				Upper Bound (Million Euro)			
Domestic Receptor benefits from domestic reductions	SO2, NOX, NH3, NMVOC	PM10	CO+CO2	**Total**	SO2, NOX, NH3, NMVOC	PM10	CO+CO2	**Total**
Mortality benefits (? million / year)	292 (204 - 730)	124 (87 - 310)		**416 (291 - 1040)**	932 (652 - 2329)	224 (156 - 559)		**1156 (808 - 2888)**
Morbidity benefits (? million / year)	75	54		**129**	227	96		**323**
Crop benefits (? million / year)	16			**16**	105			**105**
Material benefits (? million / year)	61			**61**	169			**169**
Total domestic benefits from dom. Action (A)	444 (356 - 881)	178 (141 - 364)		**622 (497 - 1245)**	1432 (1153 - 2830)	320 (252 - 655)		**1752 (1405 - 3485)**
Benefits from redns. in other Cand. Countries (B)	356 (286 - 705)			**356 (286 - 705)**	1196 (961 - 2368)			**1196 (961 - 2368)**
Total domestic benefits from all reductions (A+B)	800 (642 - 1586)	178 (141 - 364)		**978 (783 - 1950)**	2628 (2114 - 5198)	320 (252 - 655)		**2948 (2366 - 5853)**
Transboundary benefits from domestic action								
Other Cand. Countries	326 (218 - 565)			**326 (218 - 565)**	1111 (743 - 1922)			**1111 (743 - 1922)**
EU	342 (229 - 592)			**342 (229 - 592)**	1254 (839 - 2169)			**1254 (839 - 2169)**
Other Countries	1928 (1290 - 3336)			**1928 (1290 - 3336)**	6238 (4173 - 10791)			**6238 (4173 - 10791)**
Transboundary benefits total (C)	2597 (1737 - 4493)		0.01	**2597 (1737 - 4493)**	8602 (5755 - 14882)		4.4	**8606 (5759 - 14886)**
Total benefits from domestic action (A+C)	3041 (2093 - 5374)	178 (141 - 364)	0.01	**3219 (2234 - 5738)**	10034 (6908 - 17712)	320 (252 - 655)	4.4	**10359 (7160 - 18367)**

Table E14: Summary Table: Total Annual Benefits in 2010: Slovakia

Annual Compliance Benefits - SLOVAKIA

	Lower Bound (Million Euro)				Upper Bound (Million Euro)			
Domestic Receptor benefits from domestic reductions	SO2, NOX, NH3, NMVOC	PM10	CO+CO2	**Total**	SO2, NOX, NH3, NMVOC	PM10	CO+CO2	**Total**
Mortality benefits (? million / year)	25 (18 - 62)	94 (66 - 234)		**119 (84 - 296)**	82 (57 - 204)	169 (118 - 422)		**251 (175 - 626)**
Morbidity benefits (? million / year)	8	40		**48**	21	73		**94**
Crop benefits (? million / year)	0.2			**0**	12			**12**
Material benefits (? million / year)	3			**3**	12			**12**
Total domestic benefits from dom. Action (A)	36 (29 - 73)	134 (106 - 274)		**170 (135 - 347)**	127 (102 - 249)	242 (191 - 495)		**369 (293 - 744)**
Benefits from redns. in other Cand. Countries (B)	277 (219 - 565)			**277 (219 - 565)**	741 (586 - 1511)			**741 (586 - 1511)**
Total domestic benefits from all reductions (A+B)	313 (248 - 628)	134 (106 - 274)		**447 (354 - 912)**	868 (688 - 1760)	242 (191 - 495)		**1110 (879 - 2255)**
Transboundary benefits from domestic action								
Other Cand. Countries	342 (229 - 592)			**342 (229 - 592)**	707 (473 - 1223)			**707 (473 - 1223)**
EU	264 (176 - 456)			**264 (176 - 456)**	647 (433 - 1120)			**647 (433 - 1120)**
Other Countries	502 (336 - 869)			**502 (336 - 869)**	992 (664 - 1717)			**992 (664 - 1717)**
Transboundary benefits total (C)	1108 (741 - 1917)		0.002	**1108 (741 - 1917)**	2346 (1570 - 4059)		2	**2348 (1572 - 4061)**
Total benefits from domestic action (A+C)	1144 (770 - 1990)	134 (106 - 274)	0.002	**1278 (876 - 2264)**	2473 (1672 - 4308)	242 (191 - 495)	2	**2717 (1865 - 4805)**

Table E15: Summary Table: Total Annual Benefits in 2010: Slovenia

Annual Compliance Benefits - SLOVENIA

	Lower Bound (Million Euro)				Upper Bound (Million Euro)			
Domestic Receptor benefits from domestic reductions	SO2, NOX, NH3, NMVOC	PM10	CO+CO2	**Total**	SO2, NOX, NH3, NMVOC	PM10	CO+CO2	**Total**
Mortality benefits (? million / year)	4 (3 - 9)	21 (15 - 53)		**25 (18 - 62)**	16 (11 - 40)	38 (27 - 95)		**54 (38 - 135)**
Morbidity benefits (? million / year)	1	9		**10**	4	16		**20**
Crop benefits (? million / year)	- 0.2			- **0.2**	1			**1**
Material benefits (? million / year)	1			**1**	2			**2**
Total domestic benefits from dom. Action (A)	6 (5 - 11)	30 (24 - 62)		**36 (29 - 73)**	23 (18 - 47)	54 (43 - 111)		**77 (61 - 158)**
Benefits from redns. in other Cand. Countries (B)	57 (45 - 118)			**57 (45 - 118)**	151 (119 - 313)			**151 (119 - 313)**
Total domestic benefits from all reductions (A+B)	63 (50 - 129)	30 (24 - 62)		**93 (74 - 191)**	174 (137 - 360)	54 (43 - 111)		**228 (180 - 471)**
Transboundary benefits from domestic action								
Other Cand. Countries	14 (10 - 25)			**14 (10 - 25)**	113 (76 - 196)			**113 (76 - 196)**
EU	38 (26 - 66)			**38 (26 - 66)**	329 (220 - 570)			**329 (220 - 570)**
Other Countries	23 (15 - 40)			**23 (15 - 40)**	162 (109 - 281)			**162 (109 - 281)**
Transboundary benefits total (C)	76 (51 - 131)		0.001	**76 (51 - 131)**	605 (405 - 1046)		1	**606 (406 - 1047)**
Total benefits from domestic action (A+C)	82 (56 - 142)	30 (24 - 62)	0.001	**112 (80 - 204)**	628 (423 - 1093)	54 (43 - 111)	1	**683 (467 - 1205)**

Table E16: Summary Table: Total Annual Benefits in 2010: Turkey

Annual Compliance Benefits - TURKEY

	Lower Bound (Million Euro)				Upper Bound (Million Euro)			
	SO2, NOX, NH3, NMVOC	PM10	CO+CO2	**Total**	SO2, NOX, NH3, NMVOC	PM10	CO+CO2	**Total**
Domestic Receptor benefits from domestic reductions								
Mortality benefits (? million / year)	260 (181 - 649)	1168 (817 - 2921)		**1428 (998 - 3570)**	529 (370 - 1323)	2382 (1664 - 5955)		**2911 (2034 - 7278)**
Morbidity benefits (? million / year)	172	774		**946**	351	1,577		**1,928**
Crop benefits (? million / year)	118			**118**	241			**241**
Material benefits (? million / year)	118			**118**	241			**241**
Total domestic benefits from dom. Action (A)	668 (589 - 1057)	942 (1591 - 3695)		**2610 (2180 - 4752)**	1362 (1203 - 2156)	3959 (3241 - 7532)		**5231 (4444 - 9688)**
Benefits from redns. in other Cand. Countries (B)	2154 (1900 - 3409)			**2154 (1900 - 3409)**	4392 (3880 - 6953)			**4392 (3880 - 6953)**
Total domestic benefits from all reductions (A+B)	2822 (2489 - 4466)	942 (1591 - 3695)		**4764 (4080 - 8161)**	5754 (5083 - 9109)	3959 (3241 - 7532)		**9623 (8324 - 16641)**
Transboundary benefits from domestic action								
Other Cand. Countries	2138 (1885 - 3382)			**2138 (1885 - 3382)**	4358 (3862 - 6899)			**4358 (3862 - 6899)**
EU	3474 (3063 - 5496)			**3474 (3063 - 5496)**	7082 (6256 - 11211)			**7082 (6256 - 11211)**
Other Countries	5210 (4594 - 8245)			**5210 (4594 - 8245)**	10634 (9383 - 16817)			**10634 (9383 - 16817)**
Transboundary benefits total (C)	10822 (9542 - 17123)		0.01	**10822 (9542 - 17123)**	22064 (19489 - 34927)		7	**22071 (19496 - 34934)**
Total benefits from domestic action (A+C)	11490 (10131 - 18180)	942 (1591 - 3695)	0.01	**13432 (11722 - 21875)**	23426 (20692 - 37083)	3959 (3241 - 7532)	7	**27302 (23940 - 44622)**

ANNEXES

Annex 2: EcoSense Model

Annex 2. Details of data inputs required for the EcoSense modelling exercise

A1 1 Air quality models

The air quality models included in ECOSENSE and applied for the damage estimations are the Windrose Trajectory Model (WTM) and the Source Receptor Ozone Model (SROM). The WTM is a user-configurable trajectory model based on the Windrose approach of the Harwell Trajectory Model developed at Harwell Laboratory, UK (Derwent et al. 1988, Derwent and Nodop 1986). SROM is a model, which estimates ozone concentration by using source-receptor matrices. These were derived from results of the EMEP Ozone Model for different reduction scenarios (Simpson et al. 1997). The model is based on the EMEP iteration model developed by David Simpson (Simpson and Eliassen 1997).

A1 2 Receptor and meteorological data

The ECOSENSE database holds data sets on the meteorology and the receptor distribution across the EU and candidate countries, which are used as input for the various models. Table B.A1 gives an overview.

Table B.A1 Environmental Data Available in the ECOSENSE Database

	Resolution	Source
Receptor distribution		
Population	Administrative units, EMEP 50 grid	EUROSTAT REGIO Database, The Global Demography Project
Production of wheat, barley, sugar beat, potato, oats, rye, rice, tobacco, sunflower	Administrative units, EMEP 50 grid	EUROSTAT REGIO Database, FAO Statistical Database
Inventory of natural stone, sandstone, zinc, galvanized steel, mortar, rendering, paint	Administrative units, EMEP 50 grid	Extrapolation based on inventories of some European cities
Meteorological data		
Wind speed	EMEP 50 grid	European Monitoring and Evaluation Programme (EMEP)
Wind direction	EMEP 50 grid	European Monitoring and Evaluation Programme (EMEP)
Precipitation	EMEP 50 grid	European Monitoring and Evaluation Programme (EMEP)

Receptor data

Population data and crop data for the EU countries are taken from the EUROSTAT REGIO database, with 1996 as base year. These data are provided at NUTS levels, for most countries down to level 3. Population data for the candidate countries are taken from 'The Global Demography Project' (http://ncgia.ucsb.edu/~uwe/pop.html) and crop data from FAO Statistical Database (http://apps.fao.org) and are provided at country level. For building material, no database is available which provides a full inventory. The stock at risk for

Europe was extrapolated within ExternE from detailed studies in different European cities. These have been extrapolated for the CIS states on the base of the population distribution. For the impact assessment the receptor data given on NUTS levels are transferred to the EMEP 50×50 km^2 grid.

Meteorological data

Annual average data on wind speed, wind direction, and precipitation which are needed as input for the WTM model are taken from the European Monitoring and Evaluation Programme (EMEP) for the base year 1990.

A1 3 Exposure-response models

By following the ExternE methodology within the current project, exposure-response models are used to derive physical impacts on the basis of receptor data and concentration levels of air pollutants. Table B.A2 gives an overview of the health and environmental effects included in the analysis. The applied exposure-response models have been compiled and critically reviewed in ExternE. See the ExternE methodology report (European Commission 1999) and further recommendations within ExternE Core/Transport for a more detailed discussion (European Commission 2000b).

Table B.A2 Health and Environmental Effects Included in the Analysis

Impact Category	Pollutant	Effects
Human Health – mortality	PM_{10} [a]	Reduction in life expectancy due to short time exposure
	SO_2, ozone	Reduction in life expectancy due to long time exposure
Human Health – morbidity	PM_{10}, ozone	Respiratory hospital admissions
		Restricted activity days
	PM_{10}	Cerebrovascular hospital admissions
		Congestive heart failure
		Cases of chronic bronchitis
		Cases of chronic cough in children
		Cough in asthmatics
		Lower respiratory symptoms
	O_3	Asthma attacks
		Symptom days
Building Material	SO_2, acid deposition	Ageing of galvanised steel, limestone, mortar, sandstone, paint, rendering, and zinc for utilitarian buildings
Crops	SO_2	Yield change for wheat, barley, rye, oats, potato, sugar beet
	Ozone	Yield change for wheat, barley, rye, oats, potato, rice, tobacco, sunflower seed
	Acid deposition	Increased need for liming
	N, S	Fertilising effects

[a] particles with an aerodynamic diameter < 10 µm, including secondary particles (sulphate and nitrate aerosols)

A1 4 Monetary values

The monetary values used as base values in the current project and recommended in ExternE by the economic expert group (European Commission 2000b) are listed in Table B.A3. These values have been derived on the basis of informal meta-analysis (in the case of the mortality values) and most recent robust estimates. Recently, several studies indicated the need to adapt the monetary valuation of health impacts in different countries based on purchasing power parities. Data for the PPP adjustment in the current project were taken from the OECD (http://www.oecd.org/std/ppp/pps.htm) and EUROSTAT.

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Table B.A3 Monetary Values Used for Economic Valuation (European Commission 2000)

Impact	Monetary value (Euro)
Health effects	
Value of Statistical Life	1,000,000 (0.7- 2.5m)
Chronic bronchitis	169330
Cerebrovascular hospital admission	16730
Respiratory hospital admission	4320
Congestive heart failure	3260
Chronic cough in children	240
Restricted activity day	110
Asthma attack	75
Cough	45
Minor restricted activity day	45
Symptom day	45
Bronchodilator usage	40
Lower respiratory symptom	8
Crops	
Barley – yield loss in decitonnes (dt)	5.4
Oats – yield loss in dt	5.6
Potato – yield loss in dt	8.2
Rice – yield loss in dt	274.4
Rye – yield loss in dt	15.6
Sugar beet – yield loss in dt	4.8
Sunflower seed – yield loss in dt	23.5
Tobacco – yield loss in dt	3902
Wheat – yield loss in dt	9.6
Fertiliser	0.43
Lime	0.017
Materials – maintenance costs per m^2	
Galvanised steel	Country specific (14 – 45)
Limestone	245
Mortar	27
Natural stone	245
Paint	11
Rendering	27
Sandstone	245
Zinc	22

3.4 Discussion of uncertainties in overall methodology

3.4.1 Uncertainties in the Impact Pathway Analysis of damages caused by Ambient Air Pollution due to emissions of SO_2, NO_X, NH_3, NMVOC, PM_{10}, and CO

In the following, the uncertainties in the impact pathway analysis are briefly discussed by distinguishing between two types, statistical and systematic uncertainty. A thorough description is given within the 2nd edition of the ExternE Methodology Report (European Commission 1999).

Statistical uncertainties

Taking into account uncertainties in all steps of the impact pathway analysis, it was shown in (Rabl and Spadaro 1999) that due to the multiplicative nature of the methodology, the results follow a lognormal distribution. This opens the possibility to use statistical instruments on the uncertainty analysis of the methodology. In ExternE uncertainty is expressed by categories A, B, C instead of statistical numbers in order not to give a false sense of the precision of the uncertainty estimates which are partly based on subjective judgements:

A = high confidence;
B = medium confidence;
C = low confidence.

According to ExternE recommendations, the impact categories addressed in this report are characterised as follows:

Mortality:	B
Morbidity:	A
Crop losses:	A
Material damage:	B.

Systematic uncertainties

Besides the statistical uncertainties, the methodology is characterised by specific systematic uncertainties caused by lack of knowledge. Some of the most important assumptions and their implications are discussed in the following.

- Parameters used for dose-response functions – health effects due to particles

Dose response functions for human health are derived from epidemiological studies, which show statistical relations between measured parameters like e.g. mass concentrations of air pollutants and health effects. However, the impacting process is not yet well known so that e.g. for particles it is not clear whether mass concentration or other factors like the type of components or number of particles are the more relevant factors. Thus, if mass concentration, which is currently used as parameter for human health effects, related to particles is not relevant, the results may be systematically over- or underestimated.

- Human health effects due to nitrates

In contrast to sulphates, no direct epidemiological evidence exits for the harmfulness of nitrates. Leaving out the impacts caused by nitrates causes the current results to be about 10 to 20 percent lower than with these impacts included.

- Approach for mortality effects

The standard "Value of Prevented Fatality" (VPF) approach, which used to be known as the 'Value of a Statistical Life' (VSL) is adopted, using the recommended values of 0.7m Euro to 2.5million Euro, with a central estimate of 1 million Euro.

- Limited geographical extension of the ECOSENSE model domain

The ECOSENSE model domain is restricted to the extension of the used EMEP 50×50 km^2 grid. Thus, some countries in the eastern part of Europe and in Asia are not covered or only covered in parts by the analysis. The influence on the results is expected not to be very large in this study, because most of the benefits are observed within the model area (s. Figure 1).

- Omitted environmental and health effects

Due to a lack of knowledge in the area of effects and dose response models not all environmental and health effects could be considered for the analysis. The current study focuses on impacts, which have been identified as the major effects from air pollution within ExternE. Effects that are omitted are e.g. impacts on ecosystems, change in biodiversity, potential effects of chronic exposure to ozone, cultural monuments, material soiling, direct and indirect economic effects of change in forest productivity, and fishery performance.

From the description of the different systematic uncertainties it can be seen that some lead to an overestimation and some to an underestimation of damage costs. While the effect of using another approach for mortality effects and the share of the uncertain nitrate effects in the results could be estimated and thus considered in the analysis, the remaining systematic uncertainties could not be assessed. Within these, although the main effects are thought to be considered by the methodology, the influence of the omission of damages due to lack in current knowledge and the influence of the limited model area are likely to be higher than the influence of using the wrong parameters for the estimation of effects due to particles. Therefore, it can be said, still having in mind also the uncertainties that could be accounted for, that the results represent an underestimation of the real environmental effects of air pollution.

3.4.2 Uncertainties in the estimation of Global warming related damage costs

This discussion of uncertainties in climate change is based on that presented in European Commission (2000b). The uncertainties about the impact of climate change are estimated in

Tol (1999a,b). These are confounded by uncertainties about the scenarios (which expand through time) and about the workings of the climate system.

Table B.A4 below displays the results for carbon dioxide for a Monte Carlo analysis with 1,000 runs. All results are based on the ‘years of life lost’ methodology for morbidity risks. Figure B.A1 depicts the uncertainty about the marginal costs of carbon dioxide emissions for a 1% PRTP and world average values. The uncertainty is large and right-skewed. The probability density can be reasonably approximated with a lognormal distribution (the line in Figure 1). In case regional values are used, the marginal costs may be negative (i.e., benefits). In this case, the positive impacts of climate change on the USA, the former Soviet Union and Japan may dominate the negative impacts on other regions.

Table B.A4. The uncertainty about the marginal costs of carbon dioxide (in Euro/tC) according to *FUND*2.0.[a]

	EU only	Regional values	World average	EU values
0% PRTP				
CENTRAL EST.	1.2	6.1	15.1	60.1
Mean	1.4	7.9	19.8	78.1
Median	1.2	7.4	15.9	63.5
Std. Dev.	0.9	4.9	14.8	56.2
Geom. Mean[b]	1.2	n.a.	16.7	66.1
Geom. Std. Dev.[c]	1.8	n.a.	1.8	1.7
1% PRTP				
Central est.	0.7	5.1	8.9	35.2
Mean	0.9	4.8	11.1	43.9
Median	0.7	4.0	9.8	38.1
Std. Dev.	0.5	3.2	7.6	29.1
Geom. Mean	0.7	n.a.	9.6	38.0
Geom. Std. Dev.	1.8	n.a.	1.7	1.7
3% PRTP				
CENTRAL EST.	0.3	4.1	3.8	14.9
Mean	0.4	2.3	4.3	16.7
Median	0.3	2.9	4.0	15.4
Std. Dev.	0.2	2.2	2.5	9.4
Geom. Mean	0.3	n.a.	3.8	14.9
Geom. Std. Dev.	1.8	n.a.	1.6	1.6

[a] Emissions are in the period 2000-2009. Costs are discounted to 2000. Time horizon is 2100. Scenario is IS92a. Morbidity risks are valued based on the value of a year life lost. The statistics are based on a Monte Carlo experiment with 1,000 runs. The assumed probability density functions are given in the Appendix.

[b] The geometric mean is the exponent of the mean of the natural logarithms of the observations. 'n.a.' stands for 'not applicable' because there are negative marginal costs in the sample.
[c] The geometric standard deviation is the exponent of the standard deviation of the natural logarithm of the observations. If the observations are log normally distributed, the 95% confidence intervals ranges from the geometric mean divided by twice the geometric standard deviation to the geometric mean times twice the geometric standard deviation.

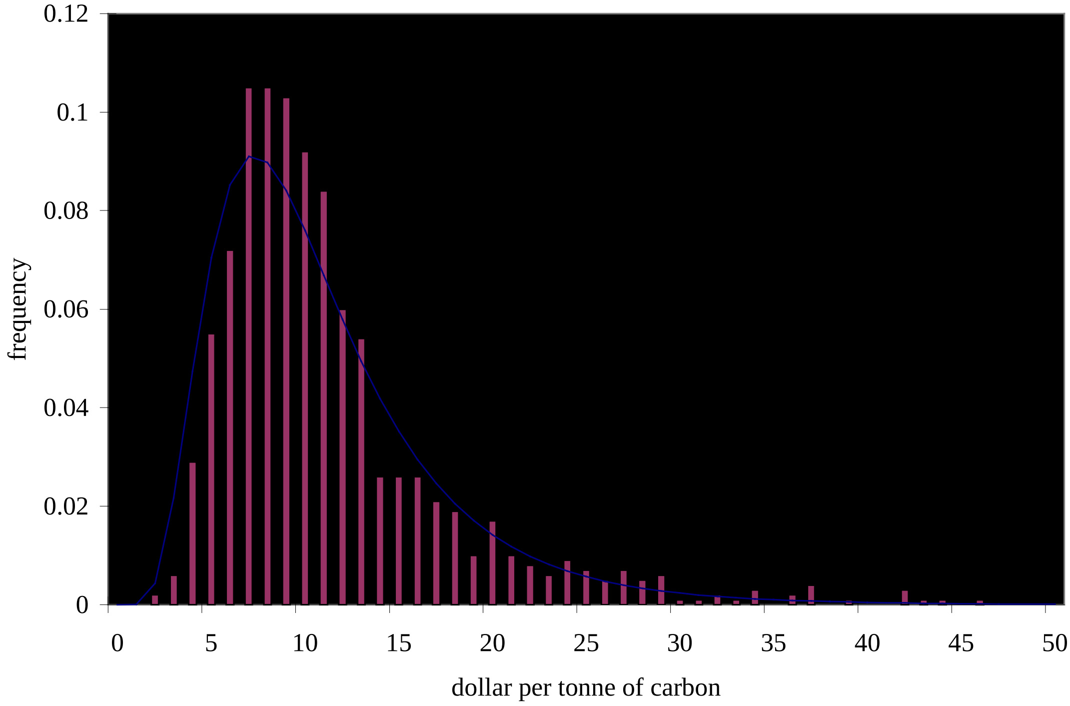


Figure B.A1. Uncertainty about the marginal costs of carbon dioxide emissions for a 1% PRTP and world average values. Source: FUND2.0; see Table B.A4.

As a sensitivity analysis, and to emphasise the 'real' uncertainties,

Table B.A5 displays what happens if the time horizon is extended from 2100 to 2200. The uncertainties get really large in the 22nd century, partly because of the uncertainty about the scenarios and partly because parameter uncertainties accumulate over time. The result is that it cannot be excluded that some economies collapse, for climate change or other reasons. If per capita income sharply declines, the discount rate becomes negative, and small changes in impacts are amplified in the net present value. This effect can be quite dramatic, and substantially increase the estimated marginal cost. However, the model was not designed for such extreme scenarios, so this result is a model artefact rather than a genuine finding. Comparing the central estimates of Tables 17 and 18, we see that there are substantial impacts of emissions in the period 2000-2009 in the 22nd century. The outcomes of the Monte Carlo experiment are trimmed, that is, the highest and lowest 5% are removed. Nevertheless, we observe an even larger increase in the mean estimate, and a substantial increase in the uncertainty, particularly for ‘world values’ and ‘EU values’ and a low discount rate.

Table B.A5. Uncertainty about the marginal costs of carbon dioxide emissions (in Euro/tC) with a time horizon up to 2200, according to *FUND*2.0.[a]

	EU only	Regional values	World values	EU values
0% PRTP				
Central est.	1.9	20.0	79.4	244.8
Mean	2.7	30.4	1849.8	3552.3
Median	2.2	22.8	123.4	350.2
Std. Dev.	1.6	21.2	7052.1	13010.6
Geom. Mean[b]	2.2	25.0	182.2	486.4
Geom. Std. Dev.[c]	1.8	1.8	6.1	5.3
1% PRTP				
Central est.	0.9	8.3	21.3	71.5
Mean	1.1	9.5	274.8	552.9
Median	1.0	8.8	28.5	89.1
Std. Dev.	0.6	4.0	981.9	1835.4
Geom. Mean	1.0	8.7	43.3	126.5
Geom. Std. Dev.	1.7	1.5	4.6	3.8
3% PRTP				
Central est.	0.3	4.3	4.4	16.8
Mean	0.4	2.7	10.4	29.1
Median	0.3	3.0	4.7	17.5
Std. Dev.	0.2	1.8	21.8	44.1
Geom. Mean	0.3	n.a.	5.7	20.0
Geom. Std. Dev.	1.6	n.a.	2.2	1.9

[a] Emissions are in the period 2000-2009. Costs are discounted to 2000. Time horizon is 2200. Scenario is IS92a. Morbidity risks are valued based on the value of a year life lost. The statistics are based on a Monte Carlo experiment with 1,000 runs. Results are trimmed for the top and bottom 5%. The assumed probability density functions are given in the Appendix.

[b] The geometric mean is the exponent of the mean of the natural logarithms of the observations. ‘n.a.’ stands for ‘not applicable’ because there are negative marginal costs in the sample.

[c] The geometric standard deviation is the exponent of the standard deviation of the natural logarithm of the observations. If the observations are lognormally distributed, the 95% confidence intervals ranges from the geometric mean divided by twice the geometric standard deviation to the geometric mean times twice the geometric standard deviation.

THE BENEFITS OF COMPLIANCE WITH THE ENVIRONMENTAL ACQUIS FOR THE CANDIDATE COUNTRIES

PART C: WATER DIRECTIVES

PART C: WATER DIRECTIVES

Contents

PART C: WATER DIRECTIVES

1.0 QUALITATIVE ASSESSMENT OF THE BENEFITS OF COMPLIANCE WITH THE WATER RELATED DIRECTIVES

This section presents the detailed assessment of the benefits of implementing the water related Directives. As with the Parts B on Air and D on waste, the assessment is carried out at three levels: a qualitative assessment of the benefits; an assessment of the extent of the benefits; and an estimate for the value of the benefits, in monetary terms. Each of the three tiers should be seen as important assessments in themselves, and not just as a route to the final monetary assessment.

Table C1 provides an overview of the type of analysis that was possible for the various Directives within the context of this study. Importantly, the methodological limitations and limitation of data availability have led to only a sub-set of the directives being assessed up to the monetary level. An analysis of the extent of benefits (see Section 2) was carried out for all Directives for which a monetary analysis was carried out (see Section 3).

Table C1: The Acquis Communautaire, and Level of Analysis for the Water Directives

Directive		**Level of Benefits Analysis**
D. Water Quality		Step 3
Water Quality Framework	2000/60/EC	Qualitative analysis
Dangerous Substances to aquatic environment	76/464, amen. Etc	Monetary assessment: implicitly
Urban waste water	91/271, amen.	Monetary assessment: implicitly
Nitrates	91/676	Monetary assessment: implicitly
Bathing Water	76/160	Monetary assessment
Drinking Water	80/778, amen.	Monetary assessment: explicitly
Surface Water for drinking	75/440, amen.	Qualitative analysis
Measurement sampling of drinking water	79/869, amen.	N/a
Ground water	80/68, amen.	Qualitative analysis
Fish water	78/659, amen.	Qualitative analysis
Shellfish Waters	79/923, amen.	Qualitative analysis

Directives excluded from the analysis include 79/869 Measurement sampling of drinking water. While this directive (and similarly for other directives) would offer some benefits, these are not amenable to a quantitative and monetary analysis, and the benefits associated with the directive are generic to all candidate countries and easily noted from the directive itself.

The discussion on the qualitative benefits covers more directives and benefits than the subsequent chapters on the extent and value of the benefits. The aim of the qualitative analysis is to highlight and explore the range of benefits from each of the directives, and present country examples, where pertinent, of the benefits and their context in the countries. Generally only a sub-set of country specific examples are presented for each benefit type, and lessons from one country are clearly of relevant to some other candidate countries. This attempts to keep Chapter 1 to a more reasonable length. Further shortening could lose some country specific detail, and make the benefits qualitative discussion too general and reduce relevance for readers from across the candidate countries.

1.1 Introduction

EU water protection policies aim to provide a wide range of environmental protection measures. Until the adoption of the water framework Directive in 2000 EU policies were generally quite specific in the issues they addressed. However, the framework Directive establishes a broad requirement for environmental protection based on ecosystem protection and the protection of human health. Overall EU water policies have taken different routes to achieving such protection. These include:

- Product standards (e.g. drinking water);
- Environmental quality standards (e.g. fishlife, dangerous substances, bathing water);
- Emission standards (e.g. dangerous substances, urban waste water).

It is important to note, however, that many areas of water protection are also delivered by other parts of the acquis, e.g. IPPC. Water Directives interact significantly with each other and, therefore benefits may accrue to receptors not specified in a Directive and receptors will benefit from action under a range of different Directives. This means that separating benefits Directive by Directive is complex and, at times impossible.

This section will identify a range of benefits derived from different Directives. It is possible to be more precise concerning health benefits, given that these have a longer history of protection under EU legislation than broad ecosystem objectives. The report distinguishes four types of benefits:

- Health (reducing impacts that are adverse to the health of human populations, e.g. water-borne diseases);
- Non-health economic exploitation (concerning impacts on aquatic resources which are economically important, i.e. for aquatic environments this mostly concerns fish and shellfish resources);
- Ecosystem (this concerns biodiversity protection);
- Social (such as access to clean bathing waters and rivers for recreation)
- Wider economic benefits (such as tourism)

The water environment and measures to protect it in the candidate countries show significant diversity and a need for a wide range of significant improvements in order to meet EU requirements. Key facts illustrating this include:

- In the ten CEE candidate countries, 40% of the rural population area does not have their waste water treated, while in urban areas the corresponding value is 18%. The scale of the "treatment gap" gives an indication of the scale of the levels of pollutants (resulting in impacts to ecosystems and health) reaching many receiving waters.

- Drinking water connection rates across the candidate countries vary between 60% and 99%. However, it is the quality of the water supplied that is of great concern, with a wide range of contaminant problems, most predominantly lead and pesticides.

- Some improvement in general river quality has taken place since 1990, mainly driven by declines in agricultural inputs. Currently about 27% of rivers in the ten CEE candidate countries have a biological oxygen demand (BOD) greater than 5 mgO2/l, compared with about 5% of rivers in western Europe and about 23% in southern Europe.

- Agricultural impacts are variable. Pesticide use has declined, but phosphate inputs are particularly elevated in parts of the Czech Republic, Hungary and Romania. A similar trend is noted for nitrates.

1.2 Water Framework Directive

1.2.1 Introduction

The Water Framework Directive (2000/60/EC) was finally agreed on the 23 October 2000. It has a long implementation period and, of course, no Member State has yet implemented it. It covers a very wide range of issues in a comprehensive way. Some of its provisions are likely to be interpreted in different ways and it will be some time before it is clear what is the precise nature of the benefits to existing Member States of its implementation. However, it is possible to identify some general issues that should bring immediate benefits to candidate countries.

The Directive sets the overall goal for surface waters as good ecological status, i.e. it is an ecosystem-based approach, not one based on individual chemical parameters. It also requires integrated management of waters and full inclusion of stakeholders in the process. The Directive also requires that abstraction of surface and ground waters be managed to a sustainable level.

1.2.2 Health benefits

The Directive does not set specific health objectives, except that it requires strict action to be taken on the discharge of prescribed substances to surface and groundwaters. The list of such substances has not yet been agreed, but the general comments made on this point in considering the dangerous substances Directive are applicable here.

The Directive does refer to health issues, but only in so far that it requires the implementation of other health-related Directives (e.g. bathing waters). However, a focus on ecosystem protection can have significant knock-on health benefits. Existing Directives may limit action in some areas (e.g. treatment from small sources under the urban waste water treatment Directive) and so leave some populations at risk. However, the framework Directive requires comprehensive action to be taken to achieve good ecological status. This may include additional waste water treatment, controls on diffuse pollution, etc, which might not be regulated under existing EU legislation. This may also reduce health related contaminants in water.

The need to ensure groundwater resources are sustainable is also important where these are accessed directly by consumers. Lower water tables can lead to increased concentration of pollutants and disease is known to occur, e.g. during droughts. Taking action to ensure groundwater abstraction does not exceed recharge should assist in reducing such incidents.

Specific benefits likely in candidate countries include:

- Groundwater is the main source of drinking water in Latvia and the framework Directive will ensure that this resource is protected from contamination.

- In Malta the directive has important implications for ground water protection. Stricter legislation might help reduce the number of illegal boreholes around the island. By monitoring the quality of groundwater risk of disease from groundwater (which is used for drinking) are reduced.

- In Romania ground-water quality is particularly important in rural areas, where 45% of the total population of the country relies on approximately 1 million individual wells (abstraction levels 5 to 20m). Benefits are directly related to waste-water treatment (as above), to the landfill directive and industrial waste disposal.

- The integrated approach to the water protection and public involvement will increase the level of awareness of the public and will put pressure on authorities in order to meet requirements in all the candidate countries.

1.2.3 Non-health economic exploitation benefits

The framework Directive results in the eventual repeal of the fishlife and shellfish waters Directives, although it refers specifically to the designation of waters for economically important species and it is expected that existing designations will remain. It is not thought likely that further economic exploitation beyond such species is widespread, although other water uses (aquatic plants in rivers and coastal fisheries) may benefit from overall ecosystem protection. The Directive is likely to facilitate better management of scarce water resources and both inland and coastal fisheries in candidate countries.

1.2.4 Ecosystem benefits

The ecosystem benefits afforded by this directive are extensive. Benefits will depend on how far current ecosystems diverge from ‘good status’. Wherever pollution has been (or is) extensive or ecosystems are exploited (e.g. for minerals) major improvements will be expected. It is important to stress that the improvements will be assessed not just on individual, visible, species groups (e.g. fish), but on the whole ecosystem.

Specific benefits likely in candidate countries include:

- Action to provide improved international protection of the Danube in Hungary, Bulgaria and Romania and the Danube delta and the Black Sea, and other transboundary rivers flowing from Czech Republic.

- Improved ecosystem management of the of Daugava River basin in Latvia and the Curonian lagoon in Lithuania

- In Malta water seepage from perched aquifers drains into wider watercourses. The tapping of this water by farmers and the Water Services Corporation reduces flow and results in the loss of natural habitats. Identification of such areas and their subsequent protection will result in healthier ecosystems.

- Rehabilitation of Olt river (Romania) and River Vistula (Poland) after the extensive hydromorphological changes with associated benefits to the flora and fauna, and even climate conditions such as rainfall.

- An ecosystem approach will aid protection of rivers in Central Slovakia. The region has many mines, which were closed at the beginning of economic transformation. Now they are abandoned and water collected there is flowing out and damaging ecosystems in rivers, lakes and reservoirs.

- An ecosystem approach to protection of the Tigris and Euphrates in Turkey. Other examples for Turkey would include the number of natural lakes (Tuz lake - 1500 km2, Van lake - 3713 km2 and Sapanca lake – 47 km2 and Büyükçekmece 11 km2 – the latter two being drinking water reservoirs) and an important number of reservoirs. Untreated water discharging into these receiving environments has a negative impact on the biodiversity in these water bodies.

1.2.5 Social benefits

The Directive will provide high quality aquatic ecosystems in all Member States. This has a wide range of social benefits, including benefits to those communities affected by extensive adverse pollution, increased use of waterways for recreation, etc.

The maintenance of sustainable water levels will have long-term economic benefits (see below). This will be vitally important in ensuring the continuity of many rural communities, which may be threatened as water resources become scarce.

The Directive also requires the involvement of all stakeholders in preparing river basin plans. This consultation should take full advantage of current trends in community involvement. It is possible that public involvement in implementing this directive will be greater than any previous environmental Directive. This will have extensive social benefits in enhancing local democracy, improving the cohesion of civil society and illustrating the benefits of the European Union. However, these benefits will only accrue if the consultation procedures are seen to result in real management and environmental changes.

The requirement for international co-operation on river basin planning will also aid social understanding and cohesion between different communities across national boundaries in Member States, candidate countries and non-Member States. This will help to reduce potential areas of conflict, e.g. over water resource issues.

Specific benefits likely in candidate countries include:

- In Bulgaria the involvement of all stakeholders in preparing river basin plans is very important for the future development of the region, enhancing local democracy, improving the cohesion of civil society and achieving some economic benefits for the included communities.
- In Malta the maintenance of sustainable ground water levels ensures that future generations will have a supply of water and will not rely solely on reverse osmosis desalination plants.
- Slovakia does not suffer from water scarcity, yet the directive will enhance local democracy and contribute to the constitution of civil society. International cooperation is extremely important as well, because of the central position of Slovakia in the region and common watersheds with other countries (e.g. the Tisza watershed and its protection, especially in the light of the recent disasters).

1.2.6 Wider economic benefits

Wide economic benefits will be highly variable across the Member States and depend upon which aspects of water quality or quantity are improved by the directive. Cleaner environments will provide increased tourism from all forms of water users.

Maintenance of sustainable water levels will provide long-term economic benefits for water users, such as agriculture and industry. These sectors are important users of water and it is important for their long-term sustainability that supplies are maintained. While this may mean changes in current practice, the survival of such industries in the longer term will necessitate the maintenance of surface and groundwater sources. The implementation of the framework Directive will achieve this. Current water uses will need examining and changes in practices may need to be instituted. The Directive will require that where such practices are unsustainable (and therefore not of long-term economic benefit), they should be changed.

Specific benefits likely in candidate countries include:

- Assessing the current rate of abstraction of ground water and the sustainability of this practice will help identify the best option for Malta in terms of sustained water production, and assess the options that will be economically and environmentally beneficial.
- International cooperation may foster coordination of regional development across countries borders and increase tourism (e.g., across the border of Slovakia and Hungary). The framework Directive specifically requires and encourages the development of catchment based administrative systems across national boundaries. This will result in local co-operation rather than government-to-government communication. In particular it will ensure that social issues across frontiers will be addressed, both between candidate countries and between these states and the existing Member States. Such issues may address flood defence (e.g. the River Oder/Odra), navigation (e.g. the River Danube), industrial expansion (e.g. the Baltic coast) as well as tourism. The expected result of improved water quality will increase tourism potential of several areas such as the Mazurian Big Lakes Region in Poland.

1.3 Dangerous Substances Directive

1.3.1 Introduction

This Directive requires reducing or preventing both direct and indirect discharges of a specified list of dangerous substances to water. It requires an approach based, variously, on establishing environmental quality standards and emission limits for individual substances. The substances covered are often highly toxic, both to human beings and to aquatic organisms. The Directive is incorporated into (and repealed by) the water framework Directive, which will lead to renewed action against additional substances.

1.3.2 Health benefits

Exposure to the substances listed in the directive can lead to a wide range of diseases, from cancers to effects on nervous system activity. However, the health benefits will depend upon the degree to which individual communities are currently exposed to these substances in water. Where waters are supplied as drinking water or swimming occurs, protection should be afforded by the Drinking Water and Bathing Waters Directives respectively (see related sections). However, not all individuals are protected by these two directives. Those obtaining drinking water from direct sources, such as wells, and those undertaking recreational activity outside of designated areas may be exposed to these pollutants.

Specific benefits likely in candidate countries include:

- In Malta leakage from oil terminals, leachate from landfills and seepage of agrochemicals result in the contamination of ground water. Negative health effects from these chemicals arise from their presence in the groundwater, which may be used for irrigation or drinking, and from contaminated storm water runoff that ends up in the sea. Absorption of heavy metals by fish will also have harmful effects on people that consume them.

- An extreme example of contamination was the gold-mining unit of Baia Mare in Romania, where the unconsolidated discharging basin gave way and spilled over. In addition, heavy rains can carry industrial (dangerous) wastes down the slopes into the rivers; they can also seep into the groundwaters, polluting rural wells, as happened earlier in 2000 in the Carpathians.

- This is especially important for areas in central Slovakia, where geological conditions and extensive mining in the past influence the water quality by contamination and this together with anthropogenic impacts has an adverse effect on the water.

1.3.3 Non-health economic exploitation benefits

The presence of toxic substances in water can result in a reduction in its ease of use for a wide range of purposes, especially industrial. Toxic metals, in particular, often contaminate machinery and inhibit individual processes, even if their presence is not undesirable in itself.

Their presence in abstracted water can lead to a reduction in the ability of industry to produce products to a high enough quality to satisfy EU standards and, therefore, be available within the single market.

Specific benefits likely in candidate countries include:

- In Malta and other coastal countries with fishery and aquaculture industries, water quality affects the healthy growth of fish.

- In Slovakia there are expected to be benefits for the food processing industry, with higher quality water sources for commercial use.

1.3.4 Ecosystem benefits

Toxic substances, both metals and pesticides, are well known to affect a wide range of species, both freshwater and marine. These may be from direct toxic effects on metabolism as well as the disruption of endocrine functions. These substances are also often well known as accumulators both within the environment (e.g. sediments) and within animals (bioaccumulation). Thus they present a significant threat even in small concentrations. In particular, top predators may be under high risk.

Specific benefits likely in candidate countries include:

- The Black Sea coast of Bulgaria, Romania and Turkey,

- The Curonian lagoon (Lithuania), which is subject to elevated levels of toxic substances.

- In Malta data on levels of heavy metals in local waters, sediments and biota is very limited. However from studies carried out on locally occurring molluscs showed high levels of metals in the vicinity of Malta’s major landfill (Maghtab), the main sewage outfall (at Xghajra) and the local harbours.

- In Slovakia the main ecosystems that will benefit will be those of the Vah River watershed, the Hron River, and the watershed of rivers Bodrog and Hornad.

1.3.5 Social benefits

Contamination of waters from toxic substances will reduce the amenity value and tourism development benefits to local communities as this restricts the use of waters. Toxic effects on health, leading to impacts on nervous system functions, can place a strain on social support systems within a community and lead to a feeling of isolation of that community from the social structures of the country as a whole.

Specific benefits likely in candidate countries include:

- In Malta, Maghtab and Xghajra are perceived as highly polluted areas. The activities that occur in these areas create a sense of isolation of the communities from the rest of the Islands and often these localities perceive themselves as socially excluded / second-class citizens. Compliance will assist in improving social cohesion.

1.3.6 Wider economic benefits

Wider economic benefits will include: benefits from the cleaner resources which reduce costs to industry (e.g. pre-treatment needs for water), benefits of cleaner resources (e.g. waters used for tourism), benefits in eco-efficiency through the use of clean technologies leading to improvements in profitability, and also benefits to industries which supply equipment for removal of dangerous substances prior to their discharge. The first three are generally net benefits. Whether there are net benefits to industries supplying equipment is unclear, as some companies will win (those supplying clean technologies/processes or high quality emissions reduction equipment), and others might lose (those who supply equipment/technologies outdated by the standard requirements of the directive). Nevertheless, it is worth noting the opportunity for a certain sub-sector of industry to benefit.

1.4 Urban Waste Water Treatment Directive

1.4.1 Introduction

This Directive aims to improve both the collection and treatment of urban waste water, requiring different levels of treatment for population centres of different sizes and for receiving waters of differing sensitivity. The focus of the directive is on meeting technical standards rather than specific environmental objectives. It is particularly important to stress the benefits of the implementation of this directive, given the high costs of compliance. Currently, there is significant non-compliance in terms of incomplete connection and treatment coverage, as shown in the following table.

Table C1: Sewage Connection Rates and Waste Water Treatment Rates

Country	Sewage connection rates (% of population served)	Waste water treatment (% of population)
Bulgaria	72	63
Czech Republic	75	62
Estonia	77	72
Hungary	60	22
Latvia	49	95
Lithuania	59	52
Poland	45	45
Romania	51	*unclear*
Slovak Republic	52	20
Slovenia	53	30

Source: various statistical yearbooks and Ministry of Environment Reports
Note: that the wastewater treatment values are not strictly comparable across countries, given that the information specified for different countries, does not always relate to the same levels of treatments – mechanical, biological treatment etc.

These figures illustrate the level of improvement necessary for basic standards to be met. Across the above listed countries, 66% of the wastewater receives no treatment or only primary treatment. As a result there are a very large number of point sources of microbial contaminants, organic matter and nutrients entering surface and ground waters across the candidate countries.

1.4.2 Health benefits

Inadequately treated sewage can cause significant health problems. These are often microbial in character with similar diseases to those described under the bathing water Directive - namely light digestive diseases (stomach upsets) to fatal cases of dysentery. It is difficult to estimate the direct benefits from implementation of this directive, as it requires an understanding of how people are exposed to waste water if it is not treated properly. Examples of such exposure include:

- Swimming or other direct contact with water: although this might be covered by the bathing waters Directive, the latter Directive only covers major bathing areas and low level bathing in waters receiving untreated or only primary treated waste water could cause major illness.
- Drinking water supplies: this should not be a problem where drinking water is supplied within a distribution system as the drinking water Directive will require adequate treatment before supply. However, contamination may pose a threat for those outside this system, e.g. those relying on wells.
- Quality of life: highly polluted waters can be a major nuisance (e.g. odours) for local residents. Even if they are not subject to direct disease contagion, there can be a significant reduction in quality of life.

Specific benefits likely in candidate countries include:

- In Bulgaria implementation will reduce the health risk for the population, related to the water for drinking purposes and the agricultural products, for more than of 2 million people or 25% of population.

- In Latvia the quantity of wastewater that has been discharged without any form of treatment decreased by 90% between 1990 and 1998. This has led to an improvement of inland surface water and seawater quality in general. To improve water supply and wastewater treatment in small and medium size towns and rural areas in Latvia, the state programme “Water supply and sewerage in medium sized and small towns in Latvia” was commenced by the Ministry of Environmental Protection and regional Development in 1995. This is expected to lead to significant improvements in health benefits.

- In Malta, locally, only 10% of sewage is treated; the rest is disposed of at sea. The presence of these outfalls leads to pollution in bathing areas with the consequent risk of infections and other diseases.

- Urban areas are the most important sources of contamination of surface water in Poland. In rural areas, only 7% of households are connected to the sewage network. Without connection wastewater is often discharged directly to soil, contaminating soils and groundwaters. Therefore it is estimated that implementation will have large positive health benefits, given that wells, other direct groundwater abstraction and surface water are an important source for water consumption.

In Turkey the total number of cases resulting from infectious diseases such as dysentery and the total number of deaths registered are 24705 and 26 respectively (1998 data) – though it is difficult to estimate what share of these are attributable to water quality. However, a large share of this is due to the microbial contaminants due to discharging of untreated water is one of the main health issues. The quality of life is also lower in regions where the discharge water is not treated.

1.4.3 Non-health economic exploitation benefits

The Directive does not aim to protect any economically important resources directly. However, a general improvement in water quality should improve resources such as fish stocks if these are not subject to other major adverse anthropogenic pressures.

Most importantly the directive contributes significantly to the protection of water as a resource in itself. In particular, many drinking water sources are derived from rivers, which receive wastewater discharges. The requirements for high standards in drinking water mean that costs of treatment are often high and a reduction in contaminants in the abstracted waters can bring direct financial benefits. Such benefits will be particularly apparent on the larger rivers in the candidate countries where there are multiple discharges and abstractions. Moreover it can be anticipated that due to the implementation of the directive surface water should be more suitable for economic uses like: cooling water, industrial water. This will bring significant direct cost reductions to water intensive industries in particular.

Specific benefits likely in candidate countries include:

- In Bulgaria improving the water quality of the Black Sea will aid in fish stock recovery and it will improve the quality used for agriculture and so reduce contamination of food products.

- In Malta the use of urban wastewater treatment plants results in better seawater quality. This has positive impacts on fisheries and the aquaculture industry. The latter depends on good water quality in order to reduce stress on the fish and spreading of disease. A major source of fresh water in Malta comes from reverse osmosis desalination plants that require unpolluted seawater. The implementation of this directive would ensure that no untreated sewage is disposed at sea. Reuse of second-class water from the wastewater treatment for agriculture implies less demand on ground water for irrigation. This will slow down the depletion of the aquifer, which is a critical resource in Malta.

- In Poland implementation of the directive should improve the quality of inland waters and the Baltic Sea, so improving resources such as fish stocks. It will also protect important transboundary rivers such as the Oder.

- In Romania both the Danube and the Black Sea coast would benefit by the improvement of water quality from implementation of the directive, as along the river’s course there are a number of urban centres without wastewater treatment. This would enhance their tourist potential and allow for the regeneration of fish stocks (e.g. the sturgeon used to spawn in the Danube 20-30 years ago when the waters where clean).

- In Slovakia implementation will also influence quality of bathing waters in lakes and reservoirs, the quality of water in transboundary rivers starting in the country, e.g. the Danube catchment.

1.4.4 Ecosystem benefits

The major ecosystem focus of the directive is on the reduction in nutrient discharges and, therefore, a reduction in euthrophication in aquatic ecosystems, with due improvements to the eco-systems and associated recuperation of fish and other aquatic life. It is unclear what other sensitive areas will be designated. However, it must be noted that nutrient removal does not just arise from tertiary treatment. Significant removal also occurs with secondary treatment.

Specific benefits likely in candidate countries include:

- It is expected that the entire Baltic Sea catchment will be designated as a sensitive area under the directive, and so require phosphorus (and possibly nitrogen) removal. As a result almost the entire catchment would be subject to very high levels of nutrient removal and major improvements to the ecosystem will be expected (reduction of eutrophication, improvement on eco-systems, improving potential for fish-life).

- In Poland, it is expected that implementation of the directive should lead to a major improvement in the ecosystems in some rivers and the Baltic Sea. Most of Poland is in the catchment area of the Baltic Sea and is, therefore, expected to be designated as sensitive. This will be the largest area of such designation in the candidate countries and will be one of the most important driving forces in delivering the protection of the Baltic.

- The Danube catchment is not itself a sensitive area. But the directive is likely to create benefits for all the countries in the catchment as eutrophication levels fall.

- In Bulgaria implementation will aid the Struma, Mesta, Maritza rivers as well as the Danube.

- In Malta, Cyprus and Turkey implementation is expected to have positive impacts on reducing eutrophication in the Mediterranean Sea.

- In Slovakia there are potential significant benefits for wetlands, rivers ecosystems and biodiversity in reservoirs. Many, especially small, lakes are heavily influenced by eutrophication (e.g. Slnecne Jazera in the Senec City suffers extensive eutrophication due to a lack of a sewage system).

1.4.5 Social benefits

The degree to which social benefits occur depends upon the current level of collection and treatment. Where these are currently very poor, the discharge of untreated sewage to local rivers resulting in nuisance odours (and worse) can lead to a poor quality of life. Investment in collection and primary or secondary treatment can enhance quality of life significantly.

Specific benefits likely in candidate countries include:

- The main wastewater outlet in the south of Malta (Wied Ghammieq) often creates a pollution plume that is visible from many areas. It is noted that the presence of this plume results in a lower assessment of the local community's social position. Adequate treatment to remove this would enable the community to feel less socially disadvantaged. The removal of outfalls present next to bathing areas will also increase the recreational value of those areas.

- In Poland implementation of the directive will directly influence the quality of life of Polish society because of improvements of surface water quality leading to the improvement and extension of collection system. The biggest benefits will accrue to people who currently live in areas where the collection network does not exist and where there are no sewage treatment plants.

- In Slovakia individual collection of sewage septic tanks is often very costly, demanding also time and effort. Moreover, some less responsible citizens often penetrate the tanks letting the sewage leach to groundwaters (in order to save money paid for collection). Implementing the directive will assist in overcoming these problems.

- In Turkey proper collection of wastewater and its treatment will improve the self-esteem of people living in municipalities that provide these services. Istanbul is an excellent example of this. The successful operations of Istanbul Water and Sewerage Works were one of the most important parameters in helping win elections.

1.4.6 Wider economic benefits

Currently, poor water quality requires extensive expenditure on treatment prior to distribution or use. This will be decreased where abstracted water quality has improved. The investment in environmental technology and improvement in the skills of those working in the water industry will also assist in enhancing the economic base of the country.

Specific benefits likely in candidate countries include:

- In Estonia improved water quality is likely to provide improved conditions for the economic growth of aquaculture.

- In Latvia more efficient use of water and a reduction in the volume of wastewater from industry has led to financial savings.

- In Malta the following economic benefits are expected: Reuse of second-class water for irrigation: less groundwater extraction leading to the economic benefit of better future extractive potential of the aquifer. It is envisaged that the sludge will be reused for agriculture; the sale of sewage sludge will generate more economic activity. Having less polluted seas will encourage more tourism.

- In Poland benefits will be connected to reducing the cost of potable water treatment (in cities where drinking water is abstracted from surface water), it will also reduce costs of industry water treatment. New working places will be created in construction of sewage pipelines, waste water treatment plants, etc.

- Industry is the biggest consumer of water in Slovakia and savings from improved water quality would influence their expenditures and thus also competitiveness.

- Manufacturing industry in Turkey needs to invest in sophisticated and modern water treatment systems since the water quality directly influences their production. Also the tourism industry, which has great importance for Turkey, is very sensitive to water quality. An upgrade in this area is a direct economic gain for both manufacturing and even more so for the tourism industry.

1.5 Nitrates Directive

1.5.1 Introduction

This Directive seeks to reduce or prevent the pollution of water caused by the application and storage of inorganic fertiliser and manure on farmland. It is intended both to safeguard drinking water supplies and to prevent wider ecological damage in the form of the eutrophication of freshwater and marine waters generally.

1.5.2 Health benefits

Concentrations of more than 50mg nitrates/l in drinking water can cause methemoglobinemia, or "blue baby" disease. Reducing concentrations below this level, as proscribed by the directive, will avoid the risk of contracting this disease. Contamination of drinking water with nitrate may be associated with an increased risk of non-Hodgkin lymphoma (NHL), particularly in agricultural areas.

However, the pathway of agricultural sources of nitrates into the drinking water supply is complex and several countries in the EU estimate that it will be 5-10 years before any effects of the directive will be felt in their territories. The uncertainty associated with these estimations is also high and depends largely on weather patterns and local geology.

Specific benefits likely in candidate countries include:

- In Bulgaria compliance with the directive will reduce the health risk for 3-5% of the population connected to drinking water supply systems with higher level of nitrates in water.

- In Latvia implementation is expected to reduce pollution of groundwater from agriculture in the Kurzeme and Zemgale regions.

- In Poland agriculture is an important source of water contamination so implementation of this directive should better protect water resources. It will be important especially in the rural areas where only a limited number of water supply networks exist and farmers receive water from individual wells (where water is contaminated from local agricultural activity or poor manure storage and utilisation).

- In Malta the level of nitrate in groundwater is relatively high and must be reduced. These levels are generally attributed to leaching of artificial fertilisers and manure applied on agricultural land. Since ground water is used as a source of drinking water, it can have negative impacts on infants. Farm practice is not regulated by legislation and often certain activities such as disposal of manure are not controlled. Inadequate storage of manure, for example, has negative public health implications on nearby residential areas in terms of the spread of disease and infections.

- In Romania there are four risk-areas: two on the Southwest (the counties of Dolj and Mehedinti) and two in the Northeast (Botosani, Bacau), with an average of 75% of the wells having a higher concentration of nitrates and an incidence of methemoglobinemia of 10 cases/1,000 children under 1 year. Implementation of the nitrates Directive should assist in reducing these significant health problems.

- As many as 5% of the samples of drinking water did not fulfill Slovak technical standards in the 1998. Nitrates remain among the main problems and significant health benefits are expected from meeting the directive.

- In Turkey implementation will very probably provide benefits in the GAP (Southeastern Anatolia Project - the largest Turkish on going multi functional regional development project) area. However due to uncertainties in the pathways of agricultural sources of nitrate into the drinking water and estimations depending on meteorological conditions and local geology makes it impossible to provide a clear estimate of its health benefits.

1.5.3 Non-health economic exploitation benefits

Improved tourism value for high amenity waterways through reduced eutrophication will bring economic benefits through tourism. Reduced nitrate levels in surface and groundwaters will also result in cleaner water for use by the water supply industry and other industries. Nitrates are expensive to remove and water companies will achieve significant cost reductions in meeting the drinking water Directive standards if the Nitrates Directive is fully implemented.

Specific benefits likely in candidate countries include:

- In Malta it must be noted that groundwater has an important economic value since it is a scarce natural resource that needs to be safeguarded for future exploitation.

- In Poland there are expected to be benefits for tourism and fishing because of a reduction in eutrophication. There will also be benefits for agriculture because of the reduction of fertilisation losses.

1.5.4 Ecosystem benefits

Excessive nitrate concentrations in water can cause harm to the environment through eutrophication of water bodies, which impacts negatively on endemic organisms. Nitrates greatly stimulate the growth of algae, producing a bad smelling surface scum. Decomposition of dead algae reduces the water's dissolved oxygen content, adversely affecting fish and other aquatic life forms typical of a mature lake.

Specific benefits likely in candidate countries include:

- In the Czech Republic implementation will have a positive effect on the protection of significant soil and water ecosystems.

- Implementation in Latvia will reduce loading of nutrients to Riga Bay and Baltic Sea.

- In Poland there will be direct benefits for water resources, water and wetland ecosystems. It is estimated that about 50% of nitrates and phosphorus emitted form Poland to the Baltic Sea comes from agricultural sources.

1.5.5 Social benefits

The improved amenity value of healthy waterways will improve the quality of life of affected populations. Currently many rivers and surface waters suffer from high levels of euthrophication, leading to fish loss (and hence reductions in fishing benefits, whether for pleasure, for own consumption, or for sale), and a reduction in the waters possible use as a bathing water, designated (see bathing water directive discussions) or not. The reduction in the social use of waterways due to euthrophication, can reduce the frequency of local social interaction and hence of social cohesion.

1.5.6 Wider economic benefits

The codes of good agricultural practice developed under the nitrates Directive could also improve the economic management of farms, especially in relation to fertiliser decisions. These codes may actually reduce the cost of production, by reducing fertiliser inputs, while maintaining crop productivity. Managing manure and waste can also improve the overall farming operation while improving the environment and reducing fertiliser cost.

Ruminant animals (cattle, sheep) are susceptible to nitrate poisoning since bacteria present in the rumen converts nitrate to nitrite. Horses are also more susceptible to nitrate poisoning. Improving the health of livestock through reduced nitrate runoff and cleaner water supply to livestock will also reap dividends for farmers.

Wider economic benefits will occur where ground and surface waters are used for industrial abstraction. Reduced costs resulting from the need for less treatment of such waters to remove nitrates may result in cost reductions to consumers and improved competitiveness of industry.

Specific benefits likely in candidate countries include:

- Currently no legislation exists in Malta regarding the management of farms. There is a problem of disposal of animal waste and this usually ends up at a landfill or dumped illegally in a field.
- In Poland implementation will result in an increasing market for firms involved in agricultural advice. Better quality of water in wells will also positively benefit the health of livestock. This will result in a significant improvement in the efficiency of Polish agriculture and improved competitiveness within the EU single market.
- Management of farms is still poor in Slovakia and fertilizers use is not well targeted. Better management will bring financial savings to the farmers.

1.6 Bathing Waters Directive

1.6.1 Introduction

This Directive aims to protect those engaged in swimming in designated bathing waters from contaminants in the waters. Of particular concern are microbial contaminants, which may arise from inadequately treated, wastewater and run-off from agricultural land. These contaminants can cause diseases, particularly of the alimentary system. There is a wide range of important bathing areas throughout the candidate countries, including a number of resort areas attracting very large numbers of visitors from Member States and beyond. Implementation of this directive is, therefore, important not only in protecting the health of local populations, but also in safeguarding the future of a vital economic sector.

1.6.2 Health benefits

The degree of benefit depends upon the exact nature of the current levels of contaminants and how far these differ from the standards required in the directive. Currently the directive only specifically requires the protection of swimmers, although additional benefits will accrue to other water users.

The key diseases avoided are those of the alimentary system. Microbial (both bacterial and viral) contaminants can cause a range of problems from mild disorders to major diseases such as dysentery. Some disease will occur from infection from regularly occurring intestinal bacteria, while others are diseases passed on from those already infected. Although the directive focuses on common bacteria such as faecal coliforms, treatment to remove these will also destroy a wide range of more dangerous, if infrequent, bacterial diseases. It is not easy to assess the level of the health risks, but examples of both serious and mild cases occur. Specific benefits likely in candidate countries – noting actual examples and areas of likely benefit - include:

- In Bulgaria these benefits will affect mainly some Black Sea coastal areas, which are not yet provided with urban WWTP. The benefits will diminish the health risk for over 500 000 local people and tourists.

- Ensuring that the local population is protected when using Lake Balaton in Hungary.

- In Romania although national standards are stronger than the directive, accidental pollution often occurs (from uncontrolled dumping). Problems of enforcement of regulations, stronger monitoring and control should be addressed in implementation and so reduce health problems.

- The Directive will assist in protecting the health of water users in Istria and Lake Bled, Slovenia.

1.6.3 Non-health economic exploitation benefits

There are expected to be limited benefits of this kind. However, there is a strong link between the Bathing Waters Directive and the Shellfish Waters Directive in that both require adequate wastewater treatment to reduce microbial contamination. Where there is extensive development of wastewater treatment, it may lead to a reduction in water pre-treatment requirements for water intensive industries. However, this may largely concern inland waters where there is both industrial and bathing activity, as meeting the standards of the Bathing Waters Directive will lead to improvements in water quality, which may reduce the water pre-treatment needs and costs for industry.

1.6.4 Ecosystem benefits

The Directive does not focus directly on ecosystem benefits. However, to ensure that the bathing water standards are met, upstream wastewater treatment will be necessary to reduce microbial contamination. This may be additional to that required within the urban waste water treatment Directive and, therefore, lead to knock-on reductions in other pollutants, that could adversely affect the eco-systems. These benefits, however, will be highly site specific.

1.6.5 Social benefits

The increase in confidence by the public in the standards for bathing waters (especially for families) is important in improving the quality of life. Where beaches have had low quality waters, there may be a tendency to seek bathing opportunities in locations at greater distances, thus breaking up the recreational social cohesion of some local communities.

Specific benefits likely in candidate countries include:

- In the Czech Republic implementation will require a need to develop or improve monitoring systems, which will ensure better quality of information flow to the public.

- In Malta, bathing is a particularly important source of recreation and supports social and community cohesion. Cleaner seas will help support this, and knowledge of cleaner bathing waters can be a source of comfort for parents.

- In Poland the increase in confidence by the public in the standards for bathing waters will be important because it helps to seek alternatives to the places where beaches have low quality waters. Implementation will play an important role in democratic development – local citizens (especially in tourist region) will have the ability to evaluate if the local administration has undertaken proper action to ensure that water quality is high and attractive to tourists.

- In Slovakia reservoir beaches, and rivers play an extremely important role for tourism in certain areas. The country does not have access to the sea, yet water sports are important for tourists. Improved quality of water may strengthen tourist potential and be part of regional development plans.

1.6.6 Wider economic benefits

The coastal bathing areas of candidate countries have a long history of extensive tourist use. These waters are now competing in an international market – both to attract foreign visitors and to retain domestic customers who might seek alternatives, e.g. in existing Member States.

Specific benefits likely in candidate countries include:

- The Baltic States: resorts such as Jurmala (Latvia), Palanga (Lithuania) and Parnu (Estonia) attracted very large numbers of visitors during the Soviet period. The visitor numbers have declined significantly, but the beaches should be attractive to western tourists (especially from Scandinavia) due to lower costs. However, these visitors will require high levels of bathing water quality. Attracting them would result in a major boost to local and regional economies.

- The Black Sea: the beaches of Bulgaria and Romania have traditionally attracted very large numbers of tourists from central and eastern Europe. While this is still an important market, there are now readily available alternatives and the problems of pollution in the Black Sea are now more widely appreciated. It is important to integrate bathing water protection into wider protection of the Black Sea (including implementation of other relevant EU directives) to protect this highly important economic activity and enhance it.

- The protection of economically important tourist beaches in Cyprus.

- Tourism in Malta is considered to be a key sector in the economic development of the Maltese Islands. Tourist arrivals peak during the summer months (July-September). In 1997 tourism contributed around 22.9% to the export of goods and services and employed a total of 94345 or 6.9% of the totally gainfully occupied in hotels and catering establishments. This means that in order to keep this important sector of the economy, it is vital that one of its main attractions, that is the sea, remains attractive enough for foreigners to choose Malta over other competitive destinations.

- In Slovakia tourism is important. For example, the Sirava water dam in East Slovakia has deteriorating water quality and this has a direct impact on the number of tourists and thus on the overall economy of the region.

- The beaches of Turkey are some of the most popular in the Mediterranean and have a long bathing season. They attract very large numbers of citizens of the current EU and it is important that Turkey is seen to commit itself to high standards in this area. Bathing water quality is currently often of a high standard. However, the increase in tourist development and the increase in residential development due to an expanding population will lead to ever increasing pressures from wastewater disposal. There is clearly the potential for future disruption to bathing water quality and the protection of this quality through investment in adequate treatment systems as the development that occurs will be vital to protect one of Turkey’s most important economic assets.

1.7 Drinking Water Directive

1.7.1 Introduction

This directive is a consumer protection directive that aims to ensure that water supplied is of a quality high enough to prevent diseases, etc. It does not set objectives for the environment per se, but for water following treatment. The primary problems associated with poor water quality include microbial contamination, lead and pesticides. All are a problem in candidate countries. However, it is also important to note the low level of connection to drinking water supplies in many countries. The following table illustrates this.

Table D2: Drinking Water Connection Rates – Selected Examples

Country	Drinking water connection rate (% of population)
Bulgaria	99
Czech Republic	87
Estonia	77
Hungary	90
Latvia	68
Lithuania	75
Romania	60
Slovak Republic	80
Slovenia	85

Source: various statistical yearbooks and Ministry of Environment Reports. Data not available for all countries, and data covers different years. This table is indicative.
Note: While the statistics generally present values as a % of total population, sometimes values related to % of population areas connected rather than actual population. The Bulgarian figure should be seen in this context.

1.7.2 Health benefits

The primary aim of the directive is health protection. Impure water may result in a range of health problems. These may result from long-term accumulation of contaminants (e.g. lead) or result in disease from immediate contamination (e.g. C*ryptosporidium*).

The precise benefits to the consumers in any community or country will depend upon the quality of current supplies. Removal, etc, of lead piping should lead to long-term health benefits. Reduction in microbial contamination will cause reductions in the incidence of disease proportional to the reduction in contamination that occurs.

Specific benefits likely in candidate countries include:

- In Bulgaria there is a problem from asbestos cement piping and there is also a need for a reduction of microbial contamination.

- In the Czech Republic implementation of the directive will ensure the provision of monitoring data of certain quality parameters that are not included in the existing Czech legislation. These include *Clostridium perfringens*, antimony, boron, bromates, sodium, acrylamide and epichlorohydrine.

- Due to natural geological conditions a high content of iron in drinking water is a problem in many areas of Latvia. Introduction of limits set in the directive and the installation of iron removal processes will lead to improvement of drinking water quality

- In Poland it is expected that implementation of the directive will better protect human health because about 10 – 20% of drinking water in Poland that is supplied is below the quality standards.

- Although regular monitoring in Malta of the quality of potable water reaching the consumer is undertaken this is not normally published. However, levels of nitrates, chlorides and sodium are high. Whereas high sodium and nitrate levels are linked with certain public health hazards, high chloride levels are generally linked to aesthetic and consumer preference rather than to human health standards.

- In Romania implementation should assist in ensuring continuous water supply in areas currently subject to interruptions due to incidents of disease, e.g. in some smaller towns in NE Romania.

- In Slovakia implementation will result in significant benefits due to current contamination of the public drinking water supplies in certain areas with heavy metals (i.e., antimony, arsenic) due to geological conditions.

- In large province centers of Turkey, such as Istanbul, Ankara and Izmir, drinking water quality is a very serious problem and an industry on bottling and marketing water has grown. Control of the quality of the bottled water bought at “water stations” is yet another important problem. This Directive will force the municipal administrators to provide standards for quality assurance at the preparation and the delivery systems (including the removal of old lead pipes).

1.7.3 Non-health economic exploitation benefits

The Directive has no direct benefit in this area. However, water suppliers may press for improvements in abstraction sources if treatment to meet the standards for drinking water is proving difficult, or expensive to meet.

1.7.4 Ecosystem benefits

None.

1.7.5 Social benefits

The provision of safe drinking water is viewed by many to be a basic human right. Where this is unavailable, communities may feel somewhat ignored by wider society, or the political leaders supposed to represent their needs and interests. This is undesirable in any country and the directive provides an opportunity to provide a benefit to individuals directly.

It is important to note that information provision is a key requirement under the directive. Even with derogations for technical implementation, consumers will be increasingly informed of where their water supplies fail to meet standards, thus increasing the social benefits of compliance.

Where drinking water is not potable, some communities may spend significant resources on alternative supplies, often bottled water. While many consumers will continue to purchase this source, those, which are forced to do so for health reasons, will be able to spend their income on other goods, which may result in improved quality of life in other areas.

Specific benefits likely in candidate countries include:

- In Estonia removal of the iron and hydrogen sulphide from water will make it more acceptable to the public.

- In Malta households are investing in reverse osmosis plants because of the unsatisfactory quality of drinking water. Improved quality will eliminate the need for families to invest in such water treatment systems.

- In Romania information to consumers will reduce anxiety and doubts, e.g. in Bucharest, while in general the quality of water meets standards, doubts arise after heavy rainfall given perceptions of problems of infiltration in the distribution networks.

- In Slovakia information provision may increase public awareness and motivate people to be more involved in the environmental protection and community development.

1.7.6 Wider economic benefits

With clean water supplies, new industries are possible, especially those relating to food and drink processing. Such industries use extensive quantities of water. Product standards are exceptionally rigorous, particularly within the single market, and even small levels of contaminants from water abstraction sources can result in products that fail to meet consumer protection legislation or require the need for expensive water treatment systems. Improved drinking water supplies will significantly reduce these costs and enable the food and drink processing industries of the candidate countries to become more competitive, particularly within the context of the single market of the EU.

Where drinking water supplies are currently of poor quality (either in relation to contaminants injurious to health or just in terms of colour or taste), it is common for people to buy bottled water as an alternative. With improved drinking water quality, there may be a reduction in bottled water purchases, thus resulting in elevated levels of disposal income for these populations and a reduction in the level of waste produced from disposal of bottles.

Specific benefits likely in candidate countries include:

- In Slovakia fewer people will buy water in PET-bottles (or other packages), which will influence the amount of waste produced, and pressure on building new landfills or incinerators. There will be a long-term economic benefit for the whole society.

- In Turkey it is expected that families will make significant savings from the expenses of buying bottled water, leaving disposable income free for the purchase of other goods (or savings), with subsequent impacts on the other sectors of the economy.

1.8 Surface Waters for Drinking

1.8.1 Introduction

This Directive aims to improve the water quality of those surface waters, which are used for drinking water abstraction. The quality criteria also establish different levels of treatment, which would be required prior to drinking water supply. This directive will be repealed by the Water Framework Directive, although its provisions have been incorporated within the new Directive.

1.8.2 Health benefits

The health benefits are to be realised through the supply of drinking water. It may be argued that the drinking water Directive should provide all direct health benefits and that the surface waters for drinking Directive is indirect in effect. However, it must be noted that problems with drinking water supply occur in many places, even where high levels of treatment are routine. Improving the quality of the abstracted waters can reduce such incidents. Generally similar benefits occur for health as identified for the drinking water Directive.

Specific benefits likely in candidate countries include:

- In Latvia two cities, Riga and Ventspils, use surface water for abstractions of drinking water. Protection of these sources will aid in protecting the populations of these two large cities.

- In Slovakia, because of contamination of the public drinking water supplies in certain areas with heavy metals (i.e., antimony, arsenic) due to geological conditions, implementation of this directive will have positive impact on public health.

1.8.3 Non-health economic exploitation benefits

Improving the quality of waters used for abstraction has immediate economic benefits for the water supply industry. Chemicals for water treatment are expensive and any reduction in their use will be important.

Specific benefits likely in candidate countries include:

- In Poland there will be economic benefits for the water supply industry, reducing the cost of potable water treatment.

- In Slovakia chemical treatment of water from the heavy metals is expensive and cost savings are expected from implementing the directive.

1.8.4 Ecosystem benefits

These would be marginal and limited to a few cases where there was a direct link between the water standards and individual species.

1.8.5 Social benefits

These will be similar (although of a lower order) to that of the drinking water Directive.

1.8.6 Wider economic benefits

Improving the quality of waters used for drinking water abstraction can lead to a demand for the use of the waters for other purposes, as they will require less treatment. In particular industries using significant quantities of water will seek out sources, which do not require expensive treatment prior to use.

1.9 Groundwater Directive

1.9.1 Introduction

This Directive aims to prevent or reduce the discharge of a specified list of dangerous substances to groundwaters. The Directive, in particular, recognises the long-term nature of groundwater contamination and, therefore, contributes to securing long-term sustainable water supplies for future generations. The Directive is incorporated into the water framework Directive.

1.9.2 Health benefits

The Directive protects sources of groundwater that may be used for drinking water abstraction. Thus benefits will accrue to those regions of candidate countries where underground aquifers are important.

The substances addressed in the directive are highly toxic, both metals and organic toxins. Most groundwater sources are treated prior to further use and are covered by other legislation, e.g. the drinking water Directive. If this is the case, then the drinking water Directive will provide the protection. In this case implementation of the groundwater Directive will result in the need for less water treatment and reduced costs. However, some direct use of groundwater occurs, e.g. wells in rural areas. Here contamination will present a long-term health problem. Health problems may include bacterial and viral alimentary disorders, although more prevalent will be longer-term diseases, such as nervous disorders, cancer, etc, resulting from pesticide residues and toxic heavy metals and other organic contaminants.

There are also indirect health benefits derived from regulatory action to implement the directive. This has taken place in Member States where action to reduce some discharge sources, e.g. sheep dips, has resulted in an educational benefit on safe handling of these substances in their legitimate use. This should result in reduction in the occurrence of a number of debilitating nervous system diseases.

Specific benefits likely in candidate countries include:

- In Bulgaria the main threats for groundwater quality are from discharges from abandoned mines, from ore extraction activities in general and from landfills. Prevention of groundwater contamination is expected to lead to better health protection from specific local communities.

- In Latvia a number of groundwaters are polluted. These include Incukalns – disposal site for sulphuric acid tar, Riga waste disposal site, Rumbuula airfield, Milgravis industrial zone etc.). Some sites are in the process of cleaning operations (Incukalns, Rumbula, Milgravis).

- In Malta, aquifers are the only natural water resource of the country. Consequently for continued abstraction of water, which is used in agriculture, industry and domestically it needs to be free from contaminants. Direct human contact with this water necessitates that it is pollutant free in order to prevent the spread of diseases and illness.

- In Slovakia wells are an important source of water in several rural areas especially in the East Slovak Basin, where there are sources of contamination from agricultural pesticides and stock excrements. A decrease in such contamination will have significant local health benefits.

- In large province centres in Turkey, such as Istanbul, Ankara and Izmir, drinking water is a very serious problem and some of these problems are due to metal contamination and in smaller locations private wells are still used for drinking and household use purposes. Protection of groundwater sources will benefit significant proportions of the country's population.

1.9.3 Non-health economic exploitation benefits

The Directive recognises that some groundwaters are already so contaminated that they are no longer able to be used for most purposes. The objective of the directive is to prevent further aquifers being equally contaminated. Continued contamination may result in the need for additional more expensive treatment, a search for alternative sources or even the closure of certain industries. For example food and drink industries use extensive quantities of water. Product standards are exceptionally rigorous, particularly within the single market, and even small levels of contaminants from water abstraction sources can result in products that fail to meet consumer protection legislation or require the need for expensive water treatment systems. Improved drinking water supplies will significantly reduce these costs and enable the food and drink processing industries of the candidate countries to become more competitive, particularly within the context of the single market of the EU.

Specific benefits likely in candidate countries include:

- The protection of such a scarce natural resource is important for Malta. Although fresh water from the reverse osmosis plants accounts for over 50% of Malta's drinking water supply, this is very expensive and uses a large amount of energy.

- In Slovakia the Zitny Ostrov area (the Ray Island on the Danube River) is considered the largest ground water reservoir of drinking water in central Europe. The quality of the water there is rather good (despite under limit concentration of dissolved oxygen, and water temperature above the limits) and protection of this reservoir is an important priority which implementation of this directive will assist.

1.9.4 Ecosystem benefits

There are little or no ecosystem benefits from this directive, except where contaminated groundwaters may rise to the surface. To the extent that groundwaters feed surface waters significant benefits should follow.

1.9.5 Social benefits

- These will be similar to that of the drinking water Directive to the extent that ground water is used for public and private water supply. The Directive will also result in the improvement of the state network for monitoring of quality of groundwater, which is currently generally not sufficient for the needs of observation of dangerous substances. This means, among others, better quality of information for the public.

1.9.6 Wider economic benefits

Improving the quality of groundwaters used for drinking water abstraction can lead to a demand for the use of the waters for other purposes, as they will require less treatment. In particular industries using significant quantities of water will seek out sources, which do not require expensive treatment prior to use.

Specific benefits likely in candidate countries include:

- In Malta improved groundwater quality will lead to less expenditure on water purifying technology by domestic users and those industries that use it in their natural processes

- In Slovakia many of the groundwater sources are utilised for production of mineral water for internal and foreign markets and protection will be important for the maintenance of this industry.

1.10 Shellfish Waters Directive

1.10.1 Introduction

This Directive requires the protection of water quality for those coastal areas where shellfisheries occur. The costs of its implementation and the benefits derived from it will not therefore be applicable to all candidate countries.

1.10.2 Health benefits

The directive has direct health benefits in that the reduction in contaminants (both inorganic and microbial) in water will lead to a reduction in the levels of contaminants in shellfish sold for human consumption. Although a separate consumer protection Directive exists which establishes purification periods for shellfish produced in waters with differing contamination levels, the shellfish waters Directive provides added protection. This is particularly so where regulatory authorities cannot be certain that shellfish are subject to adequate treatment (e.g. through ad hoc harvesting or immediate distribution on the quay side).

The health benefits are limited to those which may consume shellfish and they are, therefore, often culturally determined. Of particular concern is contamination with low levels of heavy metals (which can bioaccumulate and cause long-term illness under repeated consumption), as well as immediate onset of disease through microbial contamination. Such illness is typically that of the alimentary system, e.g. dysentery.

1.10.3 Non-health economic exploitation benefits

Shellfisheries are often important local centres of economic activity by fishermen, local points of sale and wider distribution, nationally and internationally. A significant number of individuals may rely on the industry and a significant proportion of income in some coastal communities may rely on functioning shellfisheries.

1.10.4 Ecosystem benefits

The Directive aims to protect shellfisheries, with a focus on the knock-on benefits for human consumers. However, it is important to note that shellfish other than those commercially exploited will also be protected as well as animals that feed upon them (and which might also be affected by pollutants). The Directive provides a high level of protection for designated coastal environments and is a major contributor to wider environmental protection afforded by the habitats and water framework Directives for these environments.

1.10.5 Social benefits

Shellfisheries may represent an old cultural tradition of economic activity in some communities, involving not just fishermen, but also distributors, etc. Often families are involved in this industry from generation to generation and are safeguarding shell fish waters from pollution can help preserve these traditions. This may form part of the community character for some coastal areas and ensuring its preservation is important in maintaining social cohesion and historic cultural identity.

1.10.6 Wider economic benefits

Shellfisheries can be highly important for the local economy (see above). However, there are wider benefits in that the presence of clean shellfish for sale in resorts, etc, is an excellent signal alongside the bathing waters Directive to give to tourists. Very similar wastewater treatment is required for both shellfish waters and bathing waters and, therefore, this directive assists in protecting wider tourism assets.

1.11 Fishlife Directive

1.11.1 Introduction

This Directive requires that waters be designated for economically important freshwater fish groups of salmonid or cyprinid fish. It then requires that a range of chemical standards for these waters be met.

1.11.2 Health benefits

These are small. The water standards are required for the fish populations to survive and it is unlikely that these transfer to fish flesh in significant quantities so as to affect consumers. However, it is important to note that some freshwater fish are consumed in large quantities in some regions and it is important to keep levels of contaminants low in fish flesh.

Specific benefits likely in candidate countries include:

- In Turkey total fresh water fish production in 1998 was 54500 tonnes. No health statistics exist for any problems that might arise from consumption, but some benefits may accrue.

1.11.3 Non-health economic exploitation benefits

The Directive is focused on this issue. Salmonid and cyprinid fish are important in many regions. In some cases they form the basis for tourism (i.e. sport fishing), while in others there is a wider commercial exploitation. Many communities are economically supported by these activities. Such fishing may be increasingly important as communities in rural areas seek ways of diversification from agricultural activity, which is undergoing a decline in many candidate countries.

It should also be noted that where designated rivers form a large area of the country, it is likely that such rivers are also used for other purposes. In particular, they may be abstraction sources for drinking water and for industrial use. Action to achieve fishlife water quality standards will also lead to a reduction in contaminants that need to be removed in expensive water treatment works prior to supply or use of such water. This may result in additional significant economic benefits.

Specific benefits likely in candidate countries include:

- In Estonia there should be significant economic benefits from freshwater sport and commercial fisheries.

- In Latvia there is the capacity to develop sport fishing tourism within the next few years, as rivers are rich with fish.

- In Poland there are many important sport fisheries. These include the mountain rivers in the south and lowland rivers throughout the country. Also important are the sport fisheries of the lakes in northeast Poland. These are important for local economies and attract visitors from a wide area.

- Fisheries are a potential source of tourism in the North part of Slovakia and there is a direct economic benefit for the local inhabitants.

1.11.4 Ecosystem benefits

The reduction in pollution necessary to protect these fish groups will result in wider ecosystem protection. However, the directive does not prevent other forms of anthropogenic pressure on these fish. The benefits in this regard are now completely overshadowed by the ecosystem benefits to the same rivers and lakes that will be provided by the water framework Directive.

1.11.5 Social benefits

Fishing, both commercial and sport, has deep cultural roots in many parts of Europe. Some species are associated with particular festivals and it is important that future exploitation of water resources does not threaten this tradition.

Specific benefits likely in candidate countries include:

- Fishing is a popular recreational activity in Estonia and it is expected that participants will benefit from improved fishlife water quality.

- Recreational fishing has a long tradition in Slovakia, yet levels of awareness on environmental and health aspects among anglers is rather low. Implementation of the directive will improve public awareness.

1.11.6 Wider economic benefits

Sport fishing is becoming increasingly important. Tourists from the current EU Member States and wider are looking to explore the fishing opportunities that exist in candidate countries. This could result in significant additional tourist expenditure for countries and, more importantly, rural communities. Wider benefits will also occur where there is a significant improvement in river water quality leading to improved amenity, causing, for example, improved property prices.

Specific benefits likely in candidate countries include:

- In Estonia the directive may be important in ensuring that traditional fisheries continue to survive.

- Many areas of Slovakia are increasingly under pressure from anthropogenic activities, including areas attracting angling tourism. Implementation will assist in protecting and promoting this economic activity.

The actual numbers of anglers and other beneficiaries of recreational opportunities linked to water resources is however very limited, with implications for the quantitative analysis are presented in Section 2.0 below.

Furthermore, one reason for currently declining fish stocks in some candidate countries (e.g. Turkey) is poor marine water quality, the other being over fishing. Improving water quality and better regulated fishing activities together are likely to increase the size of fish stick (e.g. of Danube sturgeon) and lead to wider economic benefits into the long term.

2.0 QUANTITATIVE ASSESSMENT OF THE BENEFITS OF COMPLIANCE WITH WATER RELATED DIRECTIVES

2.1 Introduction: Coverage of Quantitative Assessment

The qualitative assessment section of this chapter demonstrated that most water related directives have the potential to, directly or indirectly, affect all or most of the following benefit categories:

- Health benefits;
- Non-health economic exploitation benefits;
- Ecosystem benefits;
- Social benefits; and,
- Wider economic benefits.

For example, human health can be affected by the quality of drinking water or the quality of waters used for recreation. The quality of drinking water is directly affected by the implementation of the Drinking Water Directive but it is also affected by other directives, such as Surface Water for Drinking, Dangerous Substances, Nitrates, Urban Waste Water and Groundwater. Whilst recreational use of surface water would be affected by the directives for Bathing Water, Nitrates and Dangerous Substances, the all-encompassing nature of the Water Framework Directive suggests that its implementation can affect both drinking water and waters used for other purposes. It is not possible to make quantitative estimates regarding the contribution of each Directive to each benefit category.

Moreover, it has not been possible to undertake quantitative and monetary assessment for each of the above benefit categories. There are four reasons for this in the context of this study:

1. Dose-response functions that show the link between the existence of a pollutant (dose) and its impact on the receptor (response) only exist for a few cases. For example, although it is likely that most pollutants covered by the Dangerous Substances Directive may have negative effects on human health, there is insufficient scientific data to establish a dose-response function. This is in sharp contrast to most impacts from airborne pollutants for which there is a larger epidemiological literature and hence dose-response functions.
2. Where dose-response functions exist in the literature, the physical data necessary to apply these functions to a candidate country may be lacking. For example, epidemiological literature provides dose-response functions for microbial organisms covered by the Bathing Water Directive. Unfortunately, most candidate countries do not collect data on the actual concentrations of such organisms. Thus, when ‘dose’ in a given area is not known, it is not possible to predict the ‘response’.

3. Dose-response functions may exist in the literature but the impact (or response) may not be relevant for the candidate country. This can be illustrated by the above example of microbial organisms covered by the Bathing Water Directive. Although most countries collect data for 'response' such as mortality and number of cases of relevant illnesses as a whole, the experts we contacted during the course of this study argue that it is not possible to say what proportion of these health impacts (if any) is due to the current water pollution.
4. Finally, in some cases, dose-response functions and physical data may exist and the impact may be relevant to the area of analysis but economic data necessary for monetisation may be lacking. For example, a Directive may have a potential impact on the biological diversity. Although there is a large literature about the economic value of habitats and species conservation, there is hardly any literature analysing the economic value for diversity *per se* and hence a valuation would not be fully informative.

Given these limitations of data, it has been possible to quantify (See following Sections 2.2 to 2.5) and subsequently monetise (See Chapter 3) the following subset of benefits, based on WTP estimates for the potential benefits rather than following the dose-response methodology:

- Benefits to human health from cleaner drinking water;
- Benefits to users of water bodies (lakes and rivers) for bathing (avoided health impacts due to better quality bathing waters can be said to be embedded in these benefits); and
- Non-use benefits due to better water quality in rivers.

In addition it has been possible to assess the impact of the urban wastewater treatment directive on the level of nitrogen (N) and phosphorous (P) emissions to waterways.

It is important to clarify, up-front, the possibilities and limits to what can be assessed, as this helps present the context in which to interpret the results presented further below. It is clear that the final benefits that are estimated and presented in this chapter and Chapter 3 are going to be but a sub-set of the actual benefits likely to accrue from the proper implementation of the water related directives. Hence, the final results, and notably the final valuation of benefits result, should be seen as an underestimate of the total benefits. Furthermore, when considering the benefits, it is important that the insights presented in the qualitative section are not overlooked when decisions on projects, priorities and programmes are taken.

2.2 Benefits: Introduction to the Method of Assessment

Health benefits are twofold. They can accrue from improved quality of drinking water as well as improved quality of bathing water – the assessment of the former is presented in Section 2.3 and of the latter in Section 2.4.

Based on the discussion in the qualitative assessment section, the following directives are assumed to have a positive impact on the drinking water quality: Drinking Water, Urban Waste Water Treatment, Surface Waters for Drinking, Dangerous Substances, Groundwater, and Nitrates.

The following directives are assumed to have a positive impact on the water resources used for recreation and hence also on health (mainly through bathing): Bathing Water, Urban Waste Water Treatment and Dangerous Substances. The Water Framework Directive is likely to have impacts on human health, though the scale of such impacts is uncertain at the time of writing.

Possible methods for quantification: The quantification of the benefits can be carried out any of three ways:

a) Dose response function between pollutant concentrations and health impact. This can be done in one of two ways: (i) using local pollutant concentrations and health impact statistics, which is the ideal bottom up approach, responsive to local situations, but very data intensive; or (ii) using existing dose response functions, but linking these to local pollutant concentrations to obtain insights into the number of cases of illness and mortality. This is less onerous, marginally less responsive to the local reality, but does rely on the existent of good pollutant concentration data (see Box C1). As noted above, this has not been possible for this study given data limitations;

b) An avoided illness approach using health incidences without using a dose response function. This assumes that the implementation of the directive will lead to the eradication of health impacts. This approach requires data on illness and mortality incidence related to water pollution and subsequently some means of identifying what share of the improvements can be attributed to the directive. As noted above, this has not been possible, as there is insufficient data on illness and mortality and the share of the role of the directive in addressing these is quite unclear;

c) A willingness to pay approach, where the number of parties affected or potentially affected by the contaminants is identified. For the subsequent step of monetisation (see Section 3), this affected or potentially affected parties express a value that they would be willing to pay to avoid the pollution (sometimes studies also give willingness to accept compensation values). The first step is an identification of which parties are affected, which requires knowledge of connection rates (for those that gain new connection), and household numbers that would gain from quality improvements. For the second step, that of valuation, this can be done by a local survey, which would be more accurate, but extremely data and time intense, or by a benefits transfer approach, where the willingness to pay of the same type of situation is thought to be transferable to the candidate countries under appropriate assumptions.

Box C1: Dose Response Function Approach

The first approach requires actual dose-response functions, which estimate the change in the health impact (mortality and morbidity) associated with the change in the concentrations of relevant pollutants or microbial organisms due to the implementation of the relevant directives. Quantification is based on a simple multiplicative process, which is expressed as: Number of ill health cases = b.POP.dA

Where b is the dose-response coefficient, POP is affected population, dA is the change in the concentration of the pollutant that is causing ill health. The data required for this calculation are:

- Dose-response coefficient which is different for each pollutant-impact pathway and is usually taken from the existing epidemiological literature;
- Number of people affected;
- Change in the concentration of the relevant organisms in the base year and the end of the period (i.e. change due to the implementation of the directives);

The former two approaches allow for a quantification of the benefits in terms of illnesses avoided, and the third approach allows for quantification in terms of the number of households that are likely to benefit.

Selection of method for the study: A review of the epidemiological literature found only a limited number of relevant dose-response coefficients. Country experts were consulted during the study searched for data on the affected population and concentrations of the pollutant and microbial organisms. In the event, no comprehensive concentration data were available. Moreover, national experts have advised that the gastrointestinal diseases for which dose-response functions are available are not relevant in their country. Even if some of these diseases occur, they could not conclude that these are drinking water quality related. For example, although child mortality data exist, the portion of child mortality caused by drinking water is not known (but on the whole judged to be an insignificant portion). Data about affected population were also not readily available. For example, in Turkey, although the quality of publicly supplied water is low, the country expert stressed that it cannot be concluded that the population is exposed to low quality drinking water since consumers turn to better quality alternatives such as bottled spring water.

In the absence of concentration data, a simplified methodology could be used to estimate the health benefits. Assuming that the implementation of the relevant Directive(s) will increase the water quality to above the threshold level for health impacts, the data required to estimate health benefits is reduced to the number of ill-health cases there are at the moment and how many there will be when the directive(s) are implemented. The latter can be assumed zero. However, the national experts advise that there is no evidence in relation to water borne diseases and hence it cannot be concluded that compliance with the relevant directives will lead to any specified reduction in such illnesses.

Therefore, the third methodological option was used throughout this assessment.

2.3 Drinking Water

The complete assessment of the benefits of drinking water involves the use of a willingness to pay (WTP) estimate for ‘clean’ drinking water. This methodology requires an estimate of the total number of households that stand to benefit from the implementation of directives affecting drinking water (this section), and subsequently attributing a value to these benefits (See Chapter 3).

Benefits of improved drinking water will accrue to households that have a new connection to water supply, and to households that already have water supply, but are guaranteed better quality water. In practice, the benefits will relate to both new access to supply and to availability of improved drinking water.

Table C.3 shows the data for the number of affected households. In identifying the number of affected households, it is therefore possible to assume two extremes: one where all households are affected, and another where only those households than gain new connection benefit.

The first case – of all households - assumes that both benefits of new access and benefits of secure clean water are regarded as real benefits by households. This therefore makes less of a distinction between the proportion of the population in each candidate country has access to public water supply and those that will gain new supply. The number of all households is given in Table C3. This assumption needs to be seen in the context of what existing willingness to pay estimates have sought to measure. Where the existing WTP exercises look at quality improvements only, then the argument is entirely fair, and where WTP exercises look mainly at new supply, then this approach is less defensible.

The second case – of households with new connections – assumes that the number of ‘affected’ households should be based on the estimates of the proportion of the population who currently do not have access to clean drinking water but will gain connection to quality water. This would of course ignore the benefits of cleaner water supply to those already connected to the network. Even if the WTP estimate used as the basis of the transfer value is based on new connection, this approach could underestimate the benefits for some countries. Where the base WTP is quality based, this approach will lead to a very significant underestimate. The choice of the WTP estimate is discussed in Section 2.2.1. Table C3 present the estimate for the number of affected households, building on the estimates reported by some of the country experts during this study. The majority of the experts who could make such an estimate said this proportion was 5%. We have used this percentage for those countries we received no such estimate.

For the sake of this study, the authors feel that the benefits of improved water quality are real even for those that already have connections and that the assumption "all households" should be taken. This is particularly the case given that the WTP transfer value we have used is based on quality improvements rather than new connections.

While it is clear that this could slightly overestimate the benefits as some households with existing connection have good quality water, and some households will not gain connection to drinking water, the choice of only focusing the analysis on those households that would gain connection would likely lead to a much more significant underestimate.

Furthermore, the linkage of cleaner water to the acquis communautaire is more explicit than the linkage to increases in connection rates[1]. Hence, we have chosen the improved water quality as a truer indicator of benefits.

Table C3: Total and 'affected' households for estimating the health benefits of cleaner drinking water

Country	Total Household	Affected Household (% of total households)
Bulgaria	3,002,143	0.75 (25%)
Cyprus	22,267	0.01 (5%)
Czech Republic	3,826,296	0.19 (5%)
Estonia	533,174	0.16 (30%)
Hungary	3,934,231	0.197 (5%)
Latvia	903,952	0.045 (5%)
Lithuania	1,334,731	0.067 (5%)
Malta	129,000	0.0065 (5%)
Poland	12,862,667	1.93 (15%)
Romania	7,821,034	0.39 (5%)
Slovakia	1,986,667	0.099 (5%)
Slovenia	712,455	0.035 (5%)
Turkey	21,443,333	6.3 million (29%)
All Candidate Countries	58,711,950	10 million (17%)

Source: Household data from statistical yearbooks, affected households from candidate country experts, and where no data available standards value of 5% was used. Note that there is no requirement in the Drinking Water Directive to increase the number of connections to drinking water, though this is expected, and the numbers noted is a first estimate at this.

[1] Currently there is no explicit legislative requirement for the extension of the drinking water network, however, it is clearly likely with economic development, the general implementation of the environmental acquis, and the existing policies of extending water supply to more households, that more households will become connected to drinking water supply in the near future. Indeed, a major indirect driver for this is likely to be the Urban Waste Water Directive, as agglomerations with more than 2000 inhabitants will have to have a waste water treatment plant and associated sewage system. It is common practice when digging up the road to ensure that both waste water / sewage networks and drinking water networks are implemented together given cost savings and obvious interconnections. Hence with the progress of the UWWT Directive one could expect progress with the drinking water network.

Note totals may not add up due to rounding

2.4 Benefits to recreational users of water

The following Directives are likely to generate benefits to recreational users of water: Bathing Water, Urban Waste Water, Fishlife, Dangerous Substances and Nitrates. The quantification process requires a calculation similar to that for health benefits in which expert judgement is substituted for dose-response coefficients. The following data are required for this quantification process:

- The change in the water quantity and quality due to the implementation of a directive or relevant directives;
- How this change will affect the current water-based recreational behaviour (including swimming, angling etc);
- The affected population (usually referring to mean current population undertaking the relevant recreational activity and the change in this population with the improvement in water quantity and quality after the implementation of the relevant directives).

There could be a number of reasons why a Directive will have an effect on the quality (and quantity) of water used for recreation. However, there is very limited information about what the implementation of a Directive will entail and hence its resulting improvements to recreational waters in quantitative terms. Although by all means not the only directive of relevance, there is some work about the Urban Waste Water Directive in this context. This Directive will have a positive effect on the quality of inland and coastal waters and, in some cases, groundwater. An assessment of the effect on the quality of these various water resources is not available. However, some estimates of the effects on wastewater discharges are available from various studies. These are presented in Table C.4.

In this table the estimated reductions of phosphorous (P-tot) and nitrogen (N-tot) discharges as a result of the full implementation of the urban wastewater directive are shown. For these estimated reductions the following approach has been applied:

- The amount of N-tot and P-tot in (raw) sewage has been estimated, using standardised emission factors (per capita) and population. For Poland, Estonia and Latvia however, the amount is based on statistical data collected in specific projects;

- The discharge of nutrients by wastewater treatment plants (situation 1995) has been estimated, assuming a moderate level of treatment. Again, for Poland, Estonia and Latvia these amounts originate from statistics (1996). Additionally the discharges from households not connected to sewerage have been estimated (as far as it concerns towns with more than 2000 inhabitant (equivalents)). Together, this gives the total discharge in 1995 and 1996 of nutrients to surface (and ground) water;

- Taking into account the requirement for additional connections to sewerage (which leads to higher effluents in waste water treatment plants requiring treatment) and the various requirements for nutrient reductions for different sizes of towns as required by the directive, and the level of treatment in 1995/1996, the additional reduction of nutrients has been estimated. As no information on sensitive areas was available (which makes a difference for the required level of treatment) it has been assumed that all areas can be considered as sensitive, leading to a relatively high level of reduction.

Table C.4: Estimated reduction of N-tot and P-tot discharges due to the Urban Waste Water Directive

Country	N-reduction		P-reduction	
	kt/year	%	kt/year	%
Bulgaria	12.1	47%	2.4	52%
Cyprus	n.a.	n.a.	n.a.	n.a.
Czech Republic	9.4	33%	2.4	42%
Estonia	2.8	57%	0.15	37%
Hungary	19.3	53%	3.7	57%
Latvia	3.9	63%	0.7	68%
Lithuania	5.5	49%	1.1	54%
Malta	0.4	49%	0.1	56%
Poland	83.2	67%	12.4	71%
Romania	27.8	41%	5.3	43%
Slovakia	6.4	41%	1.4	47%
Slovenia	2.2	37%	0.4	38%
Turkey	n.a.	n.a.	n.a.	n.a.

Sources: Poland (Phare/Disae POL 101, 1997); Estonia (Phare/Disae EST 101/1, 1997); Latvia (TME, 1999); other countries (TME, 1996). No data available for Cyprus and Turkey.

It can be seen that the full implementation of the urban wastewater Directive may lead to the reduction of nutrient discharges by between 33% - 67% for N-tot and 38-71% for P-tot.

Although sewage is the main source of nutrients discharges to surface water it is likely that industrial wastewater discharges also play a role. As no information is available on these industrial discharges, it is likely that the actual reduction of nutrient discharges to surface water will be slightly higher than shown in the table.

While the reduction in K and P are important for the assessment of the extent of benefits, it has not been possible to link the information about the reduction in the N and P discharges to potential benefits to recreational uses of water. This is not only because such a link is missing but also because there are other factors unrelated to N and P concentrations in water that affect the quality of a water-related recreational experience.

Thus, the assessment of recreational benefits that will be presented in Chapter 3 follows a similar approach to the assessment of health benefits. This requires identification of the affected population and an estimate of the demand they have for better water quality for recreational purposes. This demand is based on the relevant WTP estimates found in the literature (see Section 2.2.2). Since such demand can be met by implementing a number of Directives and combinations of Directives, it would be wrong to assign these values to the predicted reductions in P and N concentrations alone.

Strictly, the best estimate for the affected population would be those undertaking water-related recreational activities. It has not been possible to collect this data. Although all countries have statistics about numbers of tourists, they do not have data about what type of recreational activity tourists undertake. This lack of information applies to both foreign and domestic tourists.

Therefore, the total adult population is assumed to be the measure for 'affected population'. This is reported in Table C.5.

Table C.5:Total Adult Population Affected by the changes in the quality of water used for recreational purposes

Country	Total Adult Population
Bulgaria	6,313,900
Cyprus	512,102
Czech Republic	8,540,385
Estonia	1,180,531
Hungary	8,356,440
Latvia	1,985,066
Lithuania	2,893,200
Malta	302,714
Poland	31,000,508
Romania	18,302,600
Slovakia	4,316,000
Slovenia	1,674,198
Turkey	45,674,300
All Candidate Countries	**131,051,945**

2.5 Changes in River Ecosystems

The following Directives are likely to lead to changes in the quality of river ecosystems: Bathing Water, Urban Waste Water, Fishlife, Surface Water for Drinking and Nitrates.

The (recreational) use benefits of an improvement in the river ecosystem are likely to have been covered in the analysis outlined above (see also Chapter 3) and not repeated to avoid double counting. Information about the changes in the river quality class has been collected for the purposes of estimating the non-use values attached to the improvements of river ecosystem quality (See Section 2.2.3). Table C.6 shows the current classification of rivers in the candidate countries and expert judgement about how this classification is likely to change after compliance with water directives. It should be noted that use has been made of country specific classifications, which are not always easily comparable. For the purpose of this study however, it has been assumed that the various classifications reflect river quality in a reasonable way.

Examples of benefits are:

- In Bulgaria, 23 rivers are of ‘good’ quality, 18 of ‘fair’ quality, the rest is of either ‘bad’ or ‘very bad’ quality. After compliance with EU water directives, 41 rivers are expected to be of ‘good’ and 59 of ‘fair’ quality. In the other candidate countries, similar results are expected.
- The Czech Republic has the biggest river length of all the candidate countries (76.000 km). At the same time, 10% of rivers are of ‘fair’ quality, 10% of ‘very bad’ quality, while the remaining 80% are of either ‘poor’ (40%) or ‘bad’ (40%) quality[2]. Compliance with EU water directives will improve this situation considerably: 10% are expected to be of ‘good’ quality, and all rivers of ‘poor’, ‘bad’ or ‘very bad’ quality are expected to improve to fair quality after successful implementation.

Table C.6: River quality classification in candidate countries (% of rivers), before and after implementation of water directives (aiming at reduction of discharges of various substances)

	Classification before compliance with water directives						**Classification after compliance with water directives**	
	Good	**fair**	**poor**	**bad**	**very bad**	**data from**	**Good**	**Fair**
Bulgaria [1]	23	18	48	11		1998	41	59
Czech republic [2]		10	40	40	10	1998	10	90
Cyprus	No rivers							
Estonia	No data							
Hungary	No data							
Latvia [3]	25	36	35	4		1997	61	39
Lithuania	No data							
Malta	No rivers							
Poland [4]	20	40	25	15		1995	60	40
Romania [5]	59	26	6	9		1999	85	15
Slovak republic [6]			45	28	27	1998	0	100
Slovenia [7]		45	48	7		1998	45	55

[2] This applies the Czech Republic’s classification of water quality. According to this classification, "poor" quality is better than "bad" quality. The classification of river quality varies somewhat across candidate countries, so a country-to-country comparison should be seen in this context to avoid misleading interpretations. The important issue is the benefit within a country from improvements in river quality.

Sources: 1. wat_bu.doc; 2. report on the environment (map on p.38); 3. www.vkmc.gov.lv/soe_engl/texts/srfwater/swt_ch1.htm; 4. www.mos.gov.pl/soe/rys38.htm (map); 5. wat_ro.doc; 6. www.szap.sk/periodoka…ava/sprava98eng/; 7. wat_slo.doc
Note: As noted in the table, data for some countries was not available.

As it was not possible to assess what the precise effect of the implementation of the various water directives (mainly Urban Waste Water Directive, the Nitrate Directive and the Dangerous Substances Directive) would be on river quality, it has been assumed that the full implementation of the various directives will have the following effects:

- Surface water classified as “poor”, “bad” or “very bad” becomes “fair”. Hence the percentage of “fair” rivers after compliance equals the share that were either “poor”, “bad” or “very bad” before compliance;
- Surface water classified as “fair” becomes “good”. Hence the percentage of “good” rivers after compliance equals the share that were either “good” or “fair” before compliance.

This seems a reasonable assumption, as the main cause of “poor”, “bad” or “very bad” water quality is the discharge of various substances by sewage, industrial discharges and agriculture and these discharges will be dealt with by the directives. The population identified as holding non-use values is the entire population of each candidate country, which is given in Table C.3. There is also the question of whether the population in EU Member States is likely to hold non-use values for the ecosystems in the candidate countries. This is further discussed in Section on monetisation.

3.0 MONETARY ASSESSMENT OF BENEFITS

The monetary assessment is based on the benefits transfer procedure, which involves borrowing the relevant WTP estimates from the existing literature (in other words, applying results from one country and transferring them to another, with appropriate weightings to reflect differences in purchasing price parity). Since it has not been possible to estimate the impacts of water directives in quantitative terms, WTP per unit of impact (such as to avoid a case of morbidity) cannot be used in this part of the assessment. In order to implement the approach adopted here, relevant WTP estimates that are expressed per unit of the affected population (adult individuals or households) and the relevant 'affected' population need to be identified. This section presents the WTP estimates used, while the discussion about affected population can be found in Chapter 2.

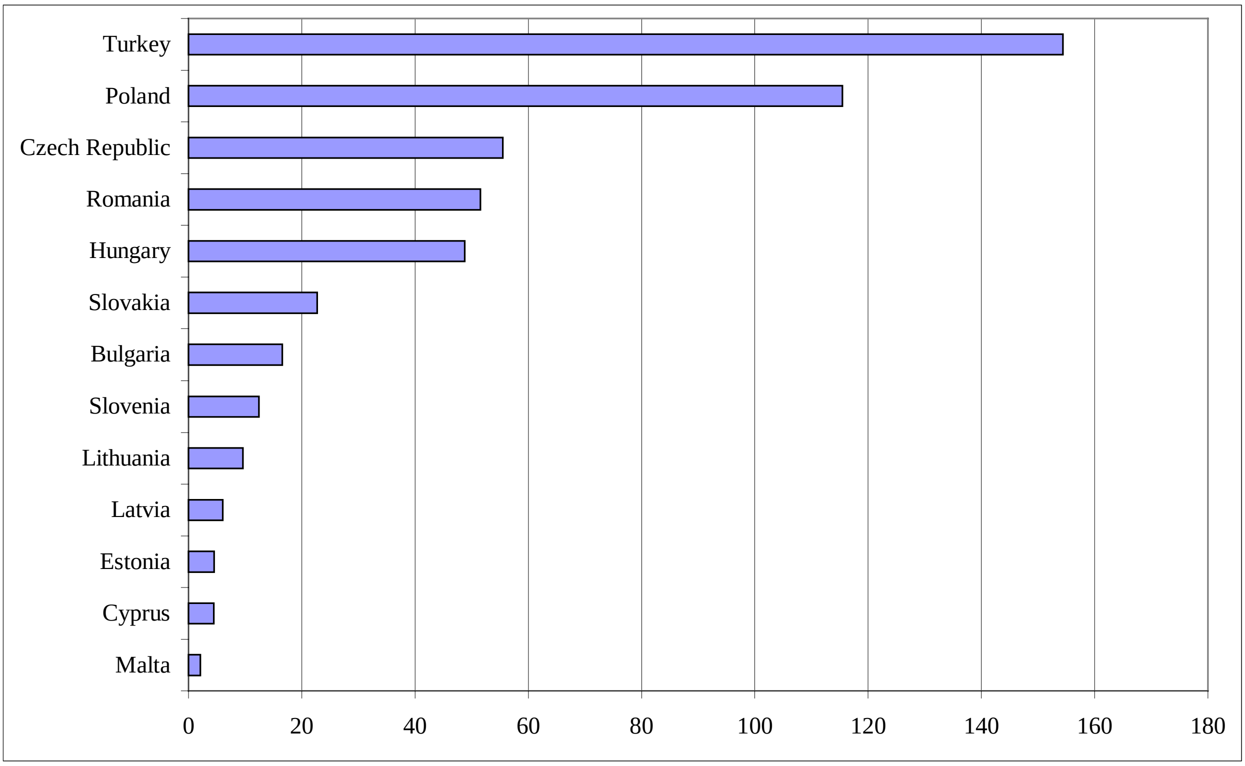
Total WTP for clean water (drinking and recreational) indicates an upper limit for use and non-use benefits covered by the analysis. The analysis does not address the question of how this demand will be met (whether by one or a combination of water related directives or by any other measure).

3.1 Benefits of Cleaner Drinking Water

The total benefits of clean drinking water are estimated to amount to 504 million EUR / year upon full compliance – for the lower WTP value and for all households (see section on Method below). The largest benefits accrue to Turkey – 154 million EUR / year – and Poland, 115 million EUR/year. The detailed results are presented in Figure C1 and Table C.7, which also shows the steps in the calculation.

For the high estimate the benefits are estimated to be significantly higher – at around 8.7 billion EUR/year upon full compliance, again with the greatest benefits likely to accrue to Turkey and Poland. The table also presents the results for the approach using "affected households" only, though as argue below (in method), this is felt to offer an unrealistic underestimate. The combination of low WTP values and all households is considered to be the appropriate lower estimate.

Figure C1: Benefits of Access to Clean Drinking Water: Lower WTP Estimate
(MEUR/yr upon full compliance)



Method: There are a number of WTP studies in the literature that elicit the respondents' demand for clean or cleaner water for drinking and in-house consumption. The full list of these studies is given in the reference section in the Annex of this Part C. The benefits transfer approach used here is to take the WTP results and adjust them for each candidate country using the individual country PPP ratios.

Table C.7: Demand for Clean Drinking Water

Country	WTP UK 1999 values; Hanley '89 (low)	WTP USA Euro 1999 (high)	GDP/capita Euro(1999) re UK	GDP/capita Euro(1999) re USA	WTP: country (low)	WTP: country (high)	Total Households	Affected Households	Low WTP All HH Million Euro/year	High WTP All HH Million Euro/year	Low WTP Affected HH Million Euro/year	High WTP Affected HH Million Euro/ year
	A	B	C	D	E=A*C	F=A*D	G	H	**E*G**	F*G	E*H	F*H
Bulgaria	25	650	0.22	0.15	5.48	95.08	3,002,143	750,536	**16.5**	285	4.1	71.4
Cyprus	25	650	0.79	0.53	19.69	341.40	222,267	11,113	**4.4**	76	0.2	3.8
Czech Republic	25	650	0.58	0.39	14.50	251.38	3,826,296	191,315	**55.5**	962	2.8	48.1
Estonia	25	650	0.34	0.23	8.51	147.51	533,174	159,000	**4.5**	78.6	1.4	23.5
Hungary	25	650	0.50	0.33	12.40	215.04	3,934,231	196,712	**48.8**	846	2.4	42.3
Latvia	25	650	0.27	0.18	6.67	115.69	903,952	45,198	**6.0**	105	0.3	5.2
Lithuania	25	650	0.29	0.19	7.16	124.13	1,334,731	66,737	**9.6**	166	0.5	8.3
Malta	25	650	0.65	0.43	16.19	280.68	129,000	6,450	**2.1**	36.2	0.1	1.8
Poland	25	650	0.36	0.24	8.97	155.58	12,862,667	1,929,400	**115.4**	2001	17.3	300
Romania	25	650	0.26	0.18	6.58	114.17	7,821,034	20,000	**51.5**	893	2.6	44.6
Slovakia	25	650	0.46	0.30	11.42	197.97	1,986,667	99,333	**22.7**	393	1.1	19.7
Slovenia	25	650	0.69	0.46	17.35	300.80	712,455	35,623	**12.4**	214	0.6	10.7
Turkey	25	650	0.29	0.19	7.20	124.86	21,443,333	6,300,000	**154.4**	2677	45.4	787
Total							58,711,950	9,811,416	**504**	8733	79	1366

This part of the assessment produces four estimates for the benefits of providing clean(er) drinking water based on two assumptions about the relevant WTP study from the study and two assumptions about the affected population in each country:

Choice of WTP

a. Lower bound WTP estimate: this is based on Hanley (1989) which elicited the WTP responses of a sample in the UK for nitrate content of drinking water to meet the standard of 50 ug/m^3 of water. The result of this study is Euro 25/household/year (in 1999 prices);

b. Upper bound WTP estimate: this is the average of the results of the following studies Jordan and Edwards (1993), Schultz and Lindsay (1990), Edwards (1988), Power (1991) and Mitchell and Carson (1986). All five measure ‘WTP to avoid groundwater contamination’. The causes include contamination by fertilisers and pesticides and WTP reflects the households’ concern for clean drinking water. An average of these five studies (Euro650/household/year in 1999 prices) is taken.

The study team has used the first value as the lower bound estimate within this study, and this clearly should be seen as an underestimate given the limited coverage of pollutants in the WTP estimate. The second value is taken as the upper bound estimate, though it is apparent that this value is likely to be more representative of the benefits than the lower bound estimate noted above.

Choice of Population numbers affected

I. All households: All households have a demand for higher drinking water quality and that this demand will be met by implementing the relevant acquis. This is probably a fair approximation of the number of people who will benefit. (those will current connections that obtain better quality water plus those without current connections that gain new quality connection). This option possibly overestimates slightly the numbers as some households already have quality water and some households will remain unconnected;

II. ‘Affected’ households only – namely those likely to gain new connection during the implementation period. Some country experts were able to provide an estimate for the proportion of the population who currently do not have access to clean drinking water that might gain connection. Assuming that this proportion will have clean water if the country complies with the relevant EU environmental directive, it is only this proportion of the population that has unmet demand for water. This is likely to be a significant underestimate as many of the households with existing connection do not yet fully benefit from quality drinking water as existing water quality is often below the norms noted in the acquis communautaire.

As noted above, the authors have chosen to use the option “a” (lower bound) and “b” (upper bound) combined with option “I” (rather than “II”) for the final benefits estimate. The option

"II" is understood to seriously underestimate the likely benefits and hence under-represent the importance of the issue.

Further detail about the WTP studies chosen can be found in Table C.A1 in the Annex of this Part C.

3.2 Bathing and other surface water quality – use values

An additional important benefit from the implementation of the water related environmental acquis is the benefit of access to quality bathing and surface waters. The overall benefits (see section on method and choice of approach further below) from the availability and use of quality bathing and surface waters amounts to around 2.5 billion EUR/year upon full compliance. The largest benefits accrue to Turkey and to Poland, where annual benefits upon full compliance are estimated at 733 and 620 million EUR/year respectively. See Figure C2 and Table C8, which also presents the method and steps in the calculation.

Figure C2: Benefits of Quality Bathing and Surface Water: Lower Bound Estimate *(MEUR/yr upon full compliance)*

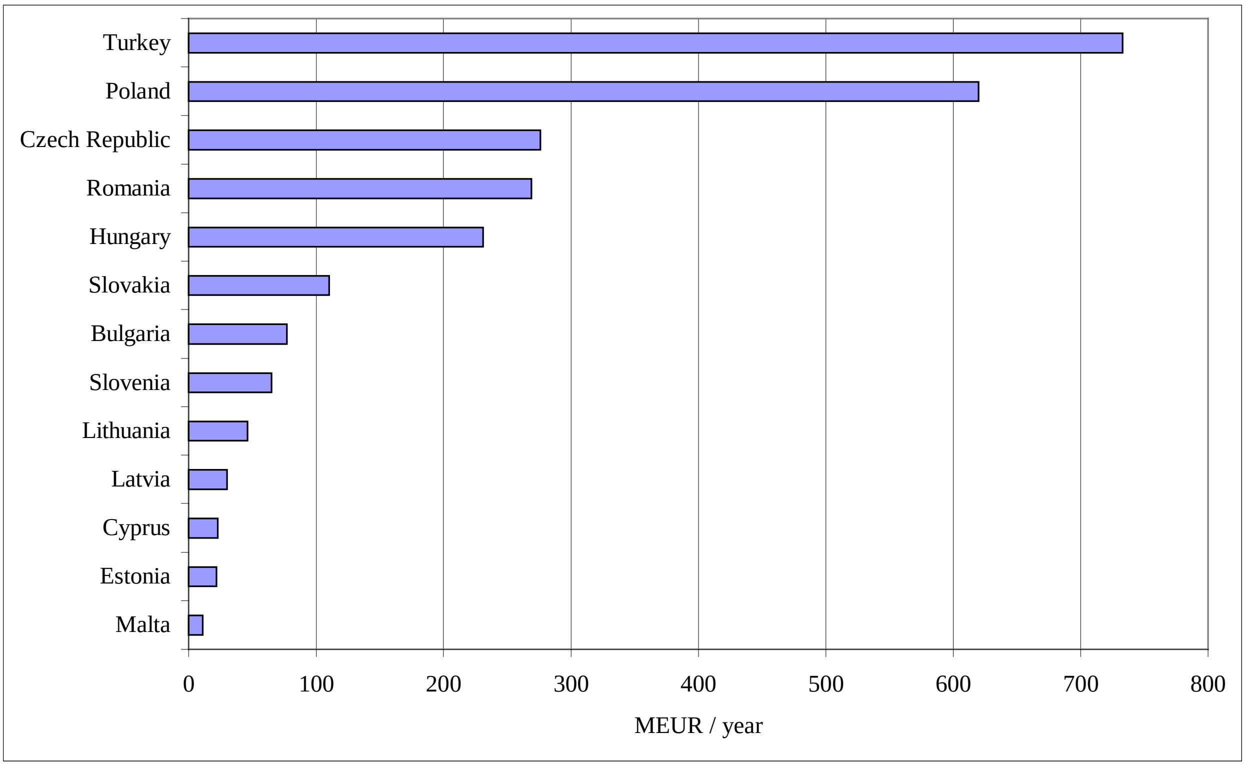


Table C.8: Bathing and other surface water quality – use values (Approaches A and B)

Country	WTP - 'mixed'	WTP per person - 'Mixed' Euro 1999	WTP per person - 'Baltic' Euro 1999	Per capita GDP in PPS (1999)	Approach A WTP – 'mixed' (Euro)	Approach B WTP - 'Baltic' (Euro)	Total Adult Population (1999)	Mixed WTP (million Euro/year)	Baltic WTP (million Euro/year)
		A	B	C	D[1]	E[1]	F	G=D*F	**H=E*F**
Bulgaria	Balaton	22.5	20	4729	9.95	12.22	6,313,900	62.8	**77.2**
Cyprus	Bosphorous	4	20	16980	10.94	43.89	512,102	5.6	**22.5**
Czech Republic	Balaton	22.5	20	12502	26.30	32.31	8,540,385	224.6	**276**
Estonia	Baltic	20	20	7336	18.96	18.96	1,180,531	22.4	**22.4**
Hungary	Balaton	22.5	20	10695	22.50	27.64	8,356,440	188.0	**231**
Latvia	Baltic	20	20	5754	14.87	14.87	1,985,066	29.5	**29.5**
Lithuania	Baltic	20	20	6174	15.96	15.96	2,893,200	46.2	**46.2**
Malta	Bosphorous	4	20	13960	8.99	36.08	302,714	2.7	**11**
Poland	Baltic	20	20	7738	20.00	20.00	31,000,508	620	**620**
Romania	Balaton	22.5	20	5678	11.95	14.68	18,302,600	218.6	**268.6**
Slovakia	Balaton	22.5	20	9846	20.71	25.45	4,316,000	89.4	**109.8**
Slovenia	Balaton	22.5	20	14961	31.47	38.67	1,674,198	52.7	**64.8**
Turkey	Bosphorous	4	20	6210	4.00	16.05	45,674,300	182.7	**733**
Total								1,745	**2,512**

1. For Balaton estimate: D=A(PPP country/PPP Hungary);*
For Bosphorous estimate: D= A (PPP country/PPP Turkey)*
For Baltic estimate: D=E=B(PPP country/PPP Poland)*

Method: There are two important assumptions to make in estimating the benefits of water related recreational activities: choosing the relevant WTP estimate and defining the relevant population. In most cases, the former choice is determined by the latter in that some WTP estimates are expressed per person or per household, while some WTP estimates are expressed per person visit or visit day.

Therefore, there are at least two options for defining the relevant population: the national population and the number of people who undertake a given type of recreation. Although the latter is likely to produce more accurate results, as mentioned in Section C.2.2, we do not have sufficient data for this. Thus, the estimates presented here are based on the national population (as opposed to per tourist or per recreational activity) for the following reasons:

- We do not know what proportion of the tourists undertake bathing water related activities;
- The study is primarily concerned with the benefits of compliance with the acquis to the in-country population;
- It is safe to assume that the whole population in the country may have a demand for improved bathing water quality; and
- In any case, the WTP of most relevance (Zylicz et al 1995 for the Baltic Sea study and Mourato, 1999 for the Lake Balaton study) are expressed either per person or per household. These estimates are averages across the part of the population who undertake recreational activities and the part that do not. This makes it possible to assume that the total national population is affected. The other study (Goksen et al, 2000 for The Bosphorous) is not related to any recreational activity at all but just the water quality for whatever reason people may value it.

The benefits have been calculated using the relevant WTP estimates in three combinations:

a. ‘Baltic’ WTP estimate: assumes that all countries have the same WTP for bathing water quality as in Poland for the Baltic Sea (Zylicz et al, 1995). This figure is Euro 20/person/year (in 1999 prices). The main reason for using this for all countries is that the study is directly related to the bathing water directive.

b. ‘Mixed’ country estimate: this uses three WTP estimates for three groups of candidate countries based on the characteristics of their bathing water resources. Baltic WTP estimate (Euro 20/person/year in 1999 prices) is used for to the Baltic States of Estonia, Latvia, Lithuania and Poland; Lake Balaton WTP estimate (Mourato, 1999) (Euro 22.5/person/year in 1999 prices) is used for the Central European countries of Bulgaria, Czech Republic, Hungary, Romania, Slovakia and Slovenia and WTP for improved water quality in Bosphorous (Goksen et al, 2000) (Euro 4/person/year in 1999 prices) is used for Turkey, Cyprus and Malta. The use of the lower WTP values found Goksen et al (2000) appear to be an underestimate, given that they are about one fifth of the WTP in most other countries.

c. Angling based on USA studies of WTP per household by Loomis (1996), Hanneman et al (1991), Olsen et al (1991) and Sanders et al (1990). The average WTP figure used here based on these studies is about Euro 129/household/year in 1999 prices. Note that angling studies do not refer to 'bathing water' but the use of especially rivers for another recreational purpose, namely, angling.

The results of these approaches (a, b and c) are NOT additive. The calculations provide an estimate of the same benefit, namely, improved water quality for recreation, based on alternative assumptions and hence should be treated as sensitivity analyses[3]. Our opinion is that approach (c) is the weakest estimate since we have no data on the extent of the angling data, this is likely to be an overestimate and approach (a) is the strongest in terms of benefits transfer as it does not adopt what looks like inappropriate differences in WTP across countries (as does option b), though perhaps the lack of differentiation of WTP (before taking the PPP into account, which does lead to some differentiation) across countries is not a perfect reflection. Overall the authors believe that (a) is less inaccurate than (b) or (c). Note that in all three approaches, the WTP estimates taken from the literature are adjusted for each candidate country using their own purchasing power parity (PPP) ratios.

Angling Benefits:

Table C.9 presents the results of using angling studies from the USA and the transfer of the results to the candidate countries (using standard benefits transfer approach). While the authors do not consider that the angling results can be added to the above calculated benefits from clean bathing and surface waters (as some of the benefits will relate to angling), it is useful to present the results of this approach. The total benefits have been estimated at 1.7 billion EUR/year upon full implementation. These values have not been added to the total aggregate benefits of implementing the EU Acquis.

[3] Approach A concentrates on bathing; approach B concentrates on bathing but the study from Turkey covers all possibilities of recreation and approach C concentrates on angling.

Table C.9: Angling benefits (Approach C)

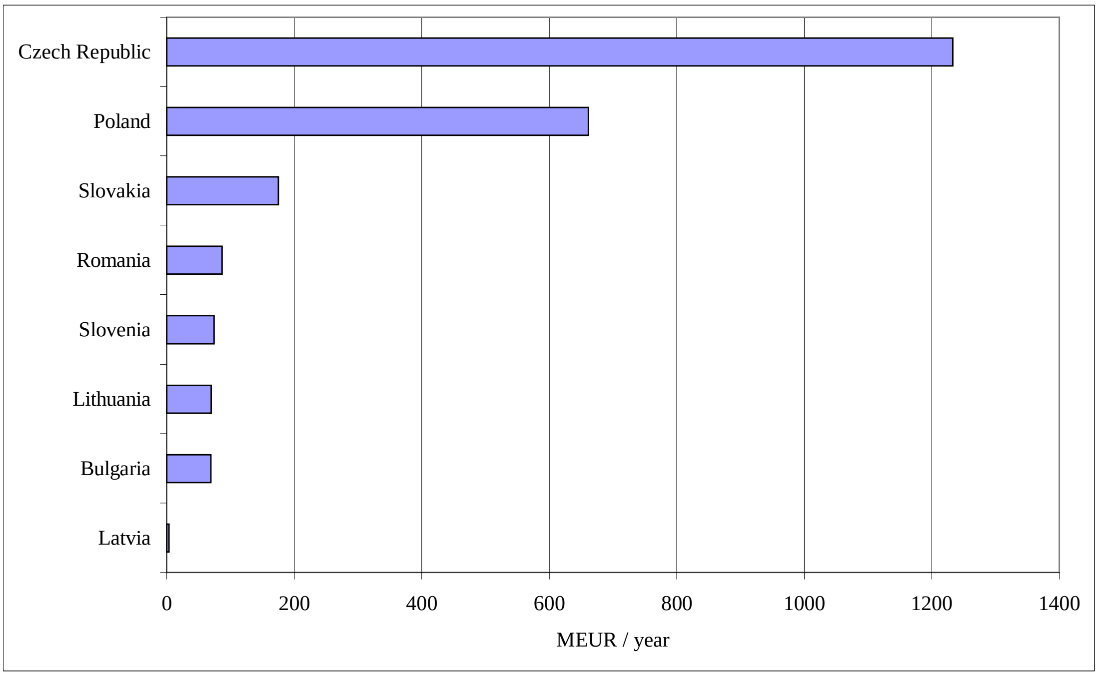
Country	USA: WTP/HH/ year: (Euro 1999)	GDP / capita PPP ratio (USA) (1999)	WTP/HH/year; country (Euro 1999)	Total Households (1999)	Total HH WTP (million Euro/year)
	A	*B*	*C=A*B*	*D*	*E=C*D*
Bulgaria	128.7	0.15	18.83	3,002,143	56.5
Cyprus	128.7	0.53	67.60	222,267	15.0
Czech Republic	128.7	0.39	49.77	3,826,296	190.4
Estonia	128.7	0.23	29.21	533,174	15.6
Hungary	128.7	0.33	42.58	3,934,231	167.5
Latvia	128.7	0.18	22.91	903,952	20.7
Lithuania	128.7	0.19	24.58	1,334,731	32.8
Malta	128.7	0.43	55.57	129,000	7.2
Poland	128.7	0.24	30.81	12,862,667	396.2
Romania	128.7	0.18	22.61	7,821,034	176.8
Slovakia	128.7	0.30	39.20	1,986,667	77.9
Slovenia	128.7	0.46	59.56	712,455	42.4
Turkey	128.7	0.19	24.72	21,443,333	530.1
All Candidate Countries					1,729

3.3 Improved river ecosystem quality – non-use value

The total benefits from improving river ecosystem quality has been estimated to amount to 2.37 billion EUR/year upon full compliance. This aggregates the benefits for a sub-set of all candidate countries, as it has not been possible to obtain sufficient data to derive a sensible estimate for some candidate countries. Those covered include: Bulgaria; Czech Republic; Latvia; Lithuania; Poland; Romania; Slovakia; Slovenia

It is therefore an underestimate for the group of countries as a whole. The benefits covers changing the quality of rivers designated as “poor” to “fair”, and those that are “fair” to “good”. While clearly some rivers will move from “poor” to “good” this has not been included, so as to have a conservative estimate (see “method” below for approach).

Figure C3: Benefits from Improved River Eco-system Quality: Lower Bound Estimate *(in MEUR/year upon full compliance)*



Note: Only those countries represented where sufficient data was available for a sensible analysis.

The largest benefits accrue to the Czech Republic, which stands to benefit around 1.2 billion EUR/year – given the extent and quality of rivers in the Czech Republic, and possibly influenced by differences in river grading systems across candidate countries[4]. Country specific results are shown in Figure C3 and in Table C8, which also shows the steps in the analysis.

[4] There is likely to be some differences across candidate countries given different approaches to the classification of rivers. While there has been some harmonisation and the values are broadly comparable, there remains room for different river categorisation. This is not going to change the prime message here – that the Czech Republic gains significantly from the implementation for the water related directives.

Method: The study chosen for benefits transfer to estimate the non-use values attached to the improved river ecosystem quality is that by Green and Willis (1996). This study elicits the non-use value attached to the changes in the classification of rivers from ‘poor’ to ‘fair’ and ‘fair’ to ‘good’. The data for length of river and more importantly river classification are lacking for some countries. However, for others this approach is implemented as follows:

1. WTP for a change from ‘poor’ to ‘fair’: it is assumed that the river classes labelled ‘poor’, ‘bad’ and ‘very bad’ will be subject to this change. Green and Willis estimate this change as Euro 0.0078/household/km of river/year (in 1999 prices),

2. WTP for a change from ‘fair’ to ‘good’: it is assumed that the river classes labelled ‘medium’ and ‘fair’ will be subject to this change. Green and Willis estimate this change as Euro 0.0029/household/km of river/year (1999 prices).

In both cases, the affected population is the national population expressed in units of households (see Table C.3). The results of the aggregation process are presented in Table C.10. Given that this is an estimate of non-use value and the other two approaches are for use value, this is additive to the other recreational benefit estimate (either approach a, b or c).

3.4 Aggregation of Benefits

Annual Benefits

The total benefit of compliance with the water related Directives has been estimated at around 5.4 billion EUR/year upon full compliance (lower estimate), and 13.6 billion EUR/year (upper estimate). Figure C4 presents the results for the candidate countries in the lower bound estimate, and Figure C5 presents the upper bound estimate. Table C 9 presents both the lower and upper estimates and the contributing benefits.

The total estimated benefit from compliance with water related Directives is based on the aggregation of the estimated benefits to health, recreational use of water and the benefits to non-users of improved (river) water resources. Angling benefits are not included.

Table C.8: Improvements to River Water Quality – Non-use Values

Country	UK: WTP/HH /km/yr poor to fair Euro 1999	UK: WTP/HH /km/year fair to good Euro 1999	GDP/capita PPP ratio Euro (1999) (re UK)	WTP/HH /km/year poor to fair: country Euro 1999	WTP/HH /km/year fair to good: country Euro 1999	Total Households	river length (km)	% of rivers classified as 'poor'	% of rivers classified as 'fair'	river km 'poor'	river km 'fair'	WTP for poor to fair (million Euro/year)	WTP for fair to good (million Euro/year)	WTP for the total change (million Euro/year)
	A	B	C	D=A*C	E=B*C	F	G	H	I	J=G*H	K=G*I	L=D*F*J	M=E*F*K	**N=L+M**
Bulgaria	0.0078	0.0029	0.22	0.0017	0.0006	3002143	19761	0.61	0.19	12054	3754	61.9	7.2	**69.1**
Cyprus	0.0078	0.0029	0.79	0.0061	0.0023	222267	0	0	0	0	0	0	0	**n/a**
Czech Republic	0.0078	0.0029	0.58	0.0045	0.0017	3826296	76000	0.9	0.1	68400	7600	1,184	48.9	**1,232.8**
Estonia	0.0078	0.0029	0.34	0.0027	0.0010	533174	31153	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	**n.d.**
Hungary	0.0078	0.0029	0.50	0.0039	0.0014	3934231	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	**n.d.**
Latvia	0.0078	0.0029	0.27	0.0021	0.0008	903952	3700	0.39	0.36	1443	1332	2.7	0.9	**3.6**
Lithuania	0.0078	0.0029	0.29	0.0022	0.0008	1334731	63700	0.01	0.97	637	61789	1.9	68.5	**70.4**
Malta	0.0078	0.0029	0.65	0.0051	0.0019	129000	0	0	0	0	0	0	0	**n/a**
Poland	0.0078	0.0029	0.36	0.0028	0.0010	12862667	33456	0.4	0.4	13382	13382	481.9	179.2	**661.1**
Romania	0.0078	0.0029	0.26	0.0021	0.0008	7821034	21934	0.15	0.26	3290.1	5703	52.9	34	**86.9**
Slovakia	0.0078	0.0029	0.46	0.0036	0.0013	1986667	24777	1	0	24777	0	175.4	0	**175.4**
Slovenia	0.0078	0.0029	0.69	0.0054	0.0020	712455	26717	0.55	0.45	14694	12023	56.7	17.2	**73.9**
Turkey	0.0078	0.0029	0.29	0.0022	0.0008	21443333	29015	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	**n.d.**
Total														**2,373**

Note: n.d.: no data; n/a: not applicable

The country that stands to benefit the most from implementing the water related directives is the Czech Republic – the benefits are estimated to range from 1.56 to 2.47 billion EUR / year upon full compliance. Poland also stands to benefit significantly, with 1.4 billion EUR/ year under the lower estimate; and a 3.28 billion EUR/year benefit under the higher estimate. Turkey is the third largest beneficiary in the lower estimate (with 0.89 billion EUR/year), but the largest under the upper estimate (around 3.4 billion EUR/year upon full compliance.). The Turkish benefits would be higher were an estimate for the benefits of improved river ecosystem quality available.

Figure C4: Annual Benefits of Full Compliance: Lower Estimate

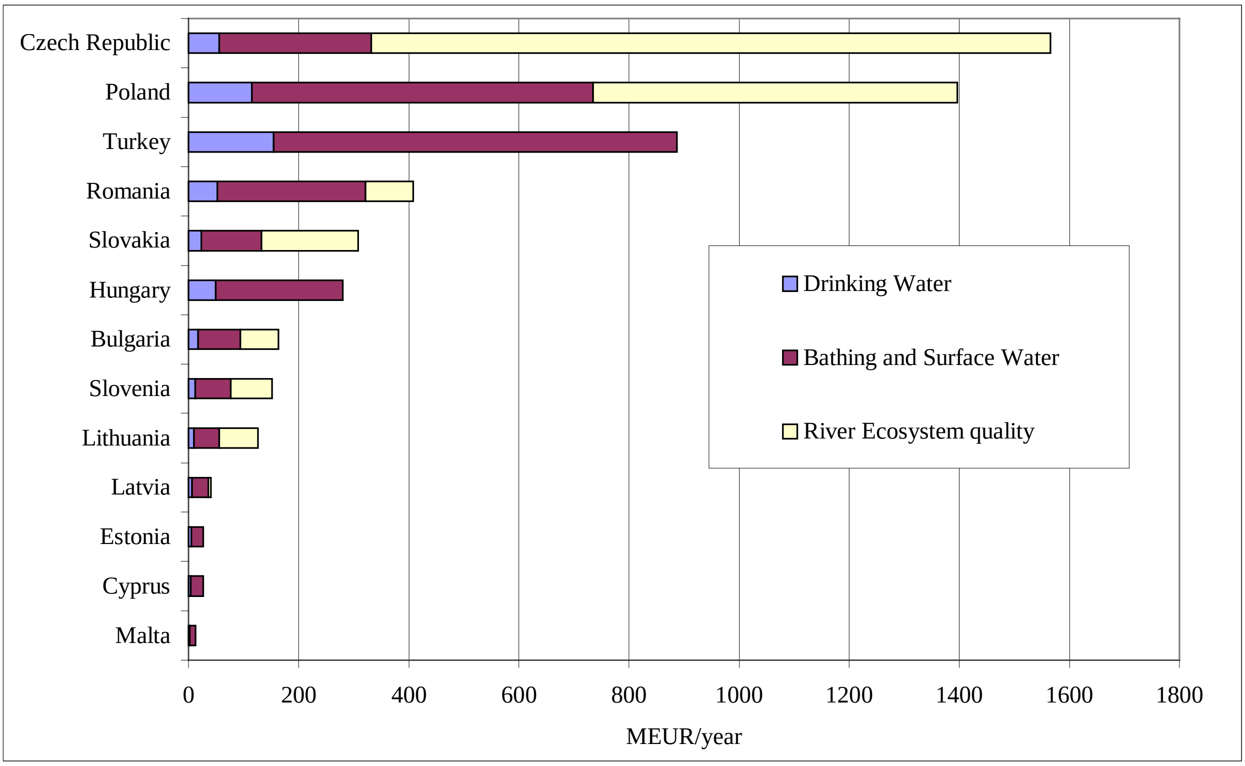


Figure C5: Annual Benefits of Full Compliance: Upper Estimate

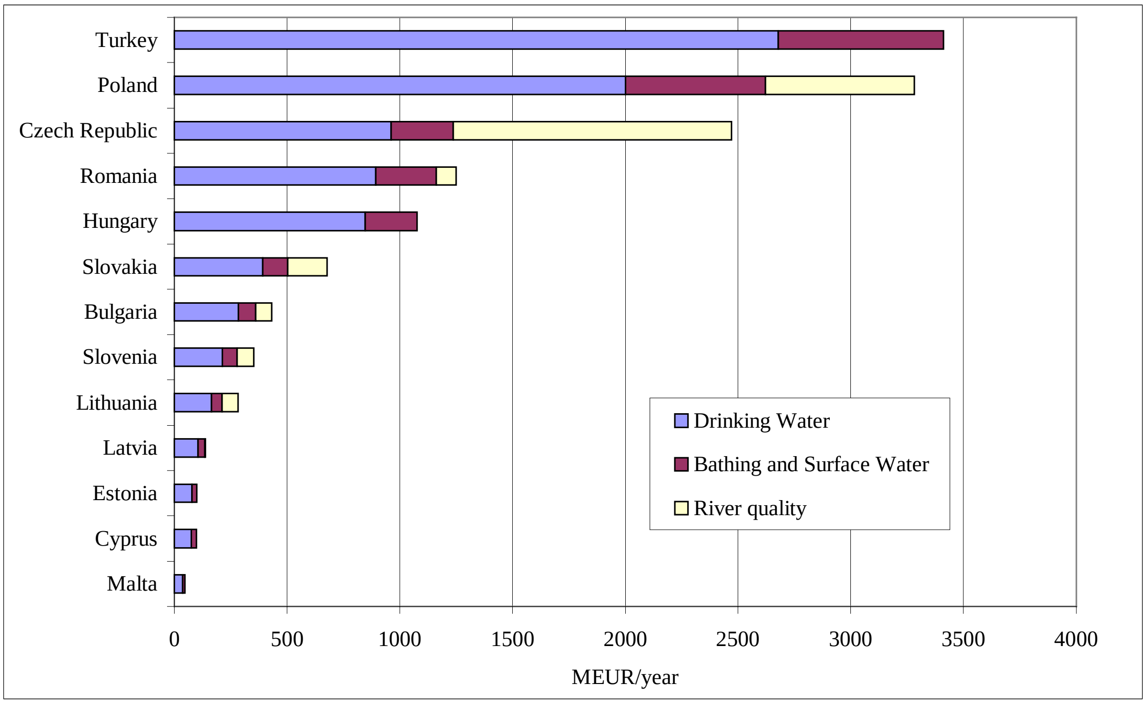


Table C.9: Aggregation of Annual Benefits from Full Compliance

	Drinking Water		Bathing and Surface Water	River quality	Total Annual Benefits from Full Compliance	
Country	Low WTP: All HHs (Million Euro/Year)	High WTP: All HH (Million Euro/Year)	Baltic WTP: Adult Pop (Million Euro/year)	WTP for the Total Quality Change (MEUR/yr)	(Million Euro/Year)	
					Lower	Higher
Bulgaria	17	285	77	69	163	432
Cyprus	4	76	23	0	27	98
Czech Republic	56	962	276	1233	1564	2471
Estonia	5	79	22	0	27	101
Hungary	49	846	231	0	280	1077
Latvia	6	105	30	4	39	138
Lithuania	10	166	46	70	126	282
Malta	2	36	11	0	13	47
Poland	115	2001	620	661	1397	3282
Romania	52	893	269	87	407	1248
Slovakia	23	393	110	175	308	679
Slovenia	12	214	65	74	151	353
Turkey	154	2678	733	0	887	3411
Total	**504**	**8734**	**2512**	**2373**	**5389**	**13619**

Note: Angling benefits have been excluded to avoid double counting.

Total Benefits over the implementation period

The above discussion focused on the annual benefits that would accrue to the candidate countries from full implementing the acquis, with the values reflecting the amount at the data of full implementation (2010). Clearly over the period up to 2010, the benefits will grow to the levels given above, and be lower in the first years as progress is made (e.g. not all rivers would move from “poor” to “fair” in the first years). Furthermore, there are clearly benefits that would accrue after 2010 (as rivers that return to “good quality” and stay “good quality” offer benefits long into the future). To arrive at a sensible estimate for the total benefits, the benefits up to the year 2020 have been taken. The present value (total value today of future benefits) has been calculated using a 4% real discount rate.

The total present value amounts to between 52 billion EUR and 133 billion EUR for the period as a whole, noting the lower and upper estimates respectively (see Table C10). It is important for the valuation here to look not just at the lower bound, but also on the upper bound. It is the study team’s view this upper bound estimate is likely to be more reflective of the benefits than the lower bound. It is also worth noting that both the lower and upper bound estimate do not include values for improvement of river quality for some countries and of course some other benefits (e.g. eco-system benefits per se) are not included in this valuation. To reiterate an important point noted throughout the study, this underlines the need to see the valuation results in conjunction with the more extensive qualitative analysis.

Table C10: Benefits of Full Compliance by Candidate Country (MEUR)

	Annual Benefits of Full Compliance (million EUR)		***Present Value (million EUR) over the period until 2020***	
Country	Low	High	Low	High
Bulgaria	160	435	1580	4200
Cyprus	25	100	260	960
Czech Republic	1560	2475	15230	24050
Estonia	27	100	260	985
Hungary	280	1080	2720	10490
Latvia	40	140	380	1340
Lithuania	125	280	1230	2750
Malta	13	47	125	460
Poland	1400	3280	13590	31960
Romania	405	1250	3960	12150
Slovakia	305	680	3000	6610
Slovenia	150	350	1470	3440
Turkey	880	3400	8640	33200
Total	**5380**	**13600**	**52400**	**132600**

Note: Total may not add to the sum of the parts given rounding.
It would be misleading to present a single central estimate as this would implicitly suggest a very accurate knowledge of the relationship between pollutant, impact and monetary benefit. Hence, the lower and upper bounds reflect the bounds of confidence in the results given methodological uncertainties.
The net present value has been calculated using a 4% real discount rate.

4.0 CONCLUSIONS

4.1 Summary conclusions: results

The study has assessed the extent and value of the following benefits:

- Benefits from the availability of drinking water and its improved quality;
- Recreational benefits from cleaner coasts, lakes and rivers for bathing;
- Transboundary benefits are reflected to a certain extent, given that all candidate countries are included in the analysis.

Given data availability, the study has not included the following benefits:

- Benefits to industrial abstractors, agriculture and aquaculture, although these are likely to be significant;
- Eco-system benefits;
- Benefits to EU Member States.

Extent of the benefits

Households are expected to benefit from access to drinking water quality as well as from its improved quality. As an example:

- In Turkey, around 6 million households (29%) are expected to benefit from new connection to drinking water.
- In Estonia, the value is similarly high (30% of all households), while in many other countries, a lower share of all households benefit.
- For households already connected, there will be significant benefits from improved drinking water quality.

River quality

The implementation of EU directives will significantly improve the quality of rivers in the candidate countries.

- In Bulgaria, 23 rivers are of ‘good’ quality, 18 of ‘fair’ quality, the rest is of either ‘bad’ or ‘very bad’ quality. After compliance with EU water directives, 41 rivers are expected to be of ‘good’ and 59 of ‘fair’ quality. In the other candidate countries, similar results are expected.
- The Czech Republic has the biggest river length of all the candidate countries (76.000 km). At the same time, not a single river is of ‘good’ quality. 10% are of ‘fair’ quality, 10% of ‘very bad’ quality, while the remaining 80% are of either ‘poor’ (40%) or ‘bad’

(40%) quality[5]. Compliance with EU water directives will improve this situation considerably: 10% are expected to be of 'good' quality, and all rivers of 'poor', 'bad' or 'very bad' quality are expected to improve to fair quality after successful implementation.

Recreational use of water

- The implementation of the Urban Waste Water Treatment Directive will lead to an improvement in the quality of coastal waters, rivers and lakes, particularly as result of reduced euthrophication following better treatment of wastewater. Discharges of nutrients are expected to fall by between 33% in the Czech Republic to 67% in Poland and phosphorous discharges from 38% in Slovenia to 71% in Poland. This creates better opportunities for recreational activities, including tourism, as well as reducing danger to fish stocks.

Value of the Benefits

Drinking Water

- New connections and cleaner drinking water resulting from EU water directives has an estimated value of 500 million to 8,7 billion EUR a year. This is based on the overall demand for clean drinking water. The demand in Turkey accounts for around a third of the total value (150 to 2.650 million EUR a year). While this study has systematically chosen the lower estimate as the appropriate focus of attention, it is important to note that the lower estimate for drinking water is very clearly an underestimate of the benefits, as only one pollutant parameter is fully covered. The higher estimate is more likely to reflect the benefits. However, to be consistent, in discussions of aggregate benefits, the lower benefits value for drinking water is used.

Bathing and other surface water quality

- The benefits from a better quality of bathing water are estimated at around 2,5 billion EUR a year. Similarly, this is based on the demand for clean bathing water.

Improved river quality

- The willingness to pay for an improvement of river quality from 'poor' to 'fair' and from 'fair' to 'good' is estimated at 2 billion EUR a year across the candidate countries. This estimate excludes the benefits from direct use, for instance for recreation. Furthermore, the estimate does not include values for certain candidate countries for which insufficient data was available.
- The Czech Republic accounts for more than half of the calculated benefits, or 1.2 billion EUR a year.

[5] This applies the Czech Republic's classification of water quality. According to this classification, "poor" quality is better than "bad" quality.

Total Value of Benefits

The total value of the benefits from implementing EU water directives across the candidate countries lies in the range of 5 to 14 billion EUR a year. When taken over the period until 2020, the value of the benefits is estimated to range from 52 billion EUR and 133 billion EUR for the 13 candidate countries as a whole. Even taking the lower estimate, it is clear that the candidate countries could benefit from timely implementation of the water related directives. Furthermore investment decisions and funding priorities could benefit from taking the benefits assessment into account.

4.2 Summary Conclusions: Methodology and interpretation of results

The analysis above covers the following benefit categories:

- Benefits to human health from cleaner drinking water estimated by people’s WTP for ‘cleaner’ water;
- Benefits to users of water bodies (lakes and rivers) for recreation (avoided health impacts due to better quality of bathing waters can be said to be embedded in these benefits) estimated by people’s WTP for bathing water recreation; and
- The non-use benefits due to better water quality in rivers estimated by WTP for better water quality for motives unrelated to current or potential use of rivers.
- Furthermore, angling benefits were also calculated explicitly, but excluded from the final aggregate benefits value, given double counting with the above estimate for recreation benefits.

The meaning of ‘cleaner’ or ‘improved’ water quality in different countries depends on the current state of the water resources and other country/population specific characteristics. While it has been possible to look at country specific environmental differences (e.g. quality and length of rivers), it has not been possible, with the available data [6], to address country-specific differences in willingness to pay (other than the differences of purchasing price parity across the countries) for various benefits.

The analysis covers some of the benefit categories discussed in the qualitative assessment section, in particular some health and ecosystem benefits. Social benefits mentioned in that section are not quantified and neither are the non-health and wider economic benefits.

The quantified and monetary estimates reflect transboundary benefits to a certain extent. Some of the rivers in the region run through a number of candidate countries. Given that all candidate countries are included in the analysis, this aspect of transboundary benefits is covered in the analysis. With the data available it is not, however, possible to attribute

[6] One would ideally take into account different grading systems for “good”, “bad” and “poor” quality, and what individuals would be actually willing to pay for such changes in the country itself. While the benefits transfer does offer a route to estimating country results, the results will not really be “country-specific”; there is the risk that the WTP in one country will not be the same as in another country, even when weighted for PPP. This is another reason for using lower and upper bounds to give a representation of the uncertainty.

benefits in one country to action in another (as w as possible in Part B on air). This would require a more bottom up approach of emissions, quality of water resources and linkage to affected parties locally, nationally and internationally.

The benefits to the EU Member States, however, are not generally covered in this analysis, with the exception of the very important benefits of reduced eutrophication in the Baltic Sea. In addition to these benefits, the populations of the EU Member States may benefit from improved water quality in candidate countries in two additional ways. The first type of benefit may arise due to the fact that some of the EU population may visit the candidate countries for water-related recreational activities. We have no data on the quantity of such visits and hence this type of benefit cannot be included in the analysis. Note that although there is data for the total number of tourists arriving in each candidate country, it is not clear where each tourist comes from and for what purpose they visit the country. The second type of benefit may be the non-use values held by the population in EU Member States for the improved water quality in candidate countries. We have no evidence of such a value existing and, if it does exist, of its magnitude. However, given that there are not many water resources in the candidate countries that are ‘unique’ in the European scale, such non-use values can be assumed to be small. Note that the water resources may be unique at the local scale and these are captured by the analysis here, which assumes that the in-country populations hold non-use values for improved water quality.

Interpretation of the results

The benefits from the implementation of the water related directives are significant, particularly for certain countries and for the upper estimate. Certain countries are “under-represented” given a lack of appropriate data, and the lower value of the benefits of drinking water arguably underestimates the true benefits. Furthermore, one could expect that any evaluation of the willingness to pay for drinking water would underestimate the benefits, given that many consumers in the candidate countries (and indeed still in many Member States) still regard water supply as a public good that is the responsibility of the government to supply, or at least to regulate and arguably subsidise prices.

It is not really possible to identify explicitly what benefits can be attributed to which particular directive. This is especially so for the water related directives given the inter-linkage of the effects of the upstream emissions related directives (e.g. UWWT and dangerous substances directives) and the down stream quality related directives (e.g. bathing water and drinking water directives). It is clear that there can be no full and appropriate implementation of the downstream directives without the upstream directives being addressed in parallel.

Finally, many will be tempted to carry out a simple cost benefits analysis, taking the benefits results from this study, and comparing to the cost estimates from other studies and drawing their own, and often incorrect, conclusions regarding the “appropriateness” of implementing the acquis. The aim of this analysis has not been to carry out such a comparison, or indeed to provide information for others to do so. While such comparisons are inevitable, it is important that those carrying out such comparisons bear in mind the meaning of the results, the limitations to the coverage of the benefits value, and the many other benefits as outlined in Section 1 that are not monetised but equally important to decisions of prioritisation of funding for the environment.

Possible next steps Finally, it is valuable to reiterate the aim of the current assessment and clarify possible ways forward for this type of analysis.

The aim was to identify the type and nature of the benefits likely to accrue from the proper implementation of the water related directives and, where possible, to assess the extent, and value of the benefits. The aim for the valuation was not to arrive at a perfect monetary equivalent, but rather to express the benefits in monetary terms in order to raise awareness of benefits and importance of implementing the acquis.

To take this analysis further, several routes are possible:

- Extend and improve the current analysis, building on better data as and when it arrives (the implementation of the directives will make good data increasingly available);
- Focus the analysis on a particular issue and go more in-depth – for example exploring the benefits of the dangerous discharge directive, where the benefits are likely to be large, difficult to assess, but important given the need to ensure compliance with this more difficult Directive
- Focus on a particular region or locality, for example a particular river basin where there are polluted rivers, contributing industry and municipalities, and the potential for tourism, recreation and fishing benefits.
- Focus on the improving the benefits assessments of particular programmes.

Independent on whether the assessment remains here, or further assessment steps are taken, it is important that the debate on the implementation of the environmental acquis increasingly take on board the issue of the benefits and not just the costs.

ANNEX

Table C.A1: Review of water-related valuation studies used in the benefit assessment

Study	Location / technique	Effect valued	Euro (1999)	Data needed for aggregation
Hanley (1989)	East Anglia, UK: CVM	WTP to benefit from a guaranteed reduction in the nitrate levels of the drinking water supplies to 50mg/l. East Anglia is one of the counties, which suffers most from excess nitrate problems in the UK. The questionnaire presented information about both the reason for payment (the existence of treatment costs) and of the then existing situation (that of water supplies occasionally in breach of the 50mg/l limit).	25.2 / household / year	Number of households affected by a change in nitrate levels of water
Jordan and Edwards (1993)	USA: CVM	WTP to guarantee clean drinking water from groundwater sources	845 - 1135.7 / household / year	Number of affected households
Schultz and Lindsay (1990)	USA	WTP to avoid contamination of groundwater resources used for public water supply including personal use values, option and bequest values.	361.6 / household / year	Number of affected households
Edwards (1988)	Cape Cod, Massachusetts, USA: CVM	WTP to provision of potable groundwater for personal use and use by future generations which is treated to the government health safety limits.	619.7 - 3090.4 / household / year	Number of affected households
Power (1991)	USA	WTP to avoid water contamination	69 / household / year	Number of affected households
Mitchell and Carson (1986)	USA	WTP to avoid water contamination	4.1 - 64 / household / year	Number of affected households

Zylicz et al (1995)	Poland: CVM	The two samples of respondents were given information about the state of water quality in the Baltic Sea and the causes of pollution. They were asked to state their WTP in the form of a tax (in the first sample a tax to be paid by all Baltic States) to finance the pollution control effort with the result of continued bathing along the shores and protection of endangered plant and animal species. The results are • Sample representative of adult population in Poland • Beach surveys with visitors (recreationalists) only	 19.9 / adult / year 97.5 / visitor / year	 Number of affected population Number of visitors
Mourato (1999)	Lake Balaton, Hungary: CVM	Lake Balaton is the largest lake in Europe. The respondents (nationally representative sample) were given information about the current state of water quality at the Lake and asked for their WTP to finance a clean-up programme which involved a set of measures to regulate the discharge of pollutants into the Lake. The respondents were told that without the clean-up programme, the water quality would deteriorate over the following 15 years.	22.5 / person / year	Number of visitors annually
Goksen et al (2000)	The Bosphorous Istanbul, Turkey: CVM	A statistically representative sample of the national population was given information about the level of pollution in The Bosphorous and asked for their WTP towards a clean-up project which will bring about visible improvements to the water quality.	4 / person / year	Number of affected population

Loomis (1996)	Elwha River, Washington State, USA: CVM	Elswha and Glines Canyon dams were built in 1913 and 1927, respectively, without any fish passage facilities and block 70 of the Elshwa River's 75 miles to migrating salmon. Most of the River flows through a National Park and hence is not subject to other pressures. Therefore, the removal of the dams would result in substantial increases in salmon and steelhead populations. Three representative samples were asked for their WTP for such a dam removal project in the form of increased federal taxes for the next 10 years. The results were reported separately for • Local households (Clallam County) • Households in the rest of the state (Washington State) • Households in the rest of the USA	62.1 / household / year 75.7 / household / year 71.2 / household / year	Number of households in the local area Number of households in the county Number of households in the rest of the country
Hanneman et al (1991)	San Joaquin River, CA, USA: CVM	WTP to increase Chinook salmon population in the San Joaquin River	205.9 - 383 / household / year	Number of households affected by the change
Olsen et al (1991)	Columbia River Basin, USA: CVM	WTP to double salmon and steelhead runs in the Columbia river including both existence and use value	56.9 / household / year	
Sanders et al (1990)	Rocky Mountains, Colorado, USA: CVM	WTP to preserve the undammed portions of three rivers in the USA, thereby preserving their fisheries. Recreational use value included that for fishing, hunting, camping, sightseeing etc. Also included but not disaggregated are option, existence and bequest values.	61.1 / household / year	Number of households affected by the change

Green and Willis (1996)	UK: CVM	WTP of anglers for improvements in water quality: • new relatively poor coarse fishery • new good coarse fishery • new good trout fishery Non-use value for improvements in (local) river water quality: • from poor to medium • from medium to good The definition of 'poor', 'medium' and 'good' is based on the statutory definitions used by the UK Environment Agency.	 5.2 / angler / visit 9.4 / angler / visit 25.2 /angler / visit 0.008 / household / km / year 0.003 / household / km / year	 Number of anglers and Number of visits per angler per year or total number of visits Number of households close to the stretch of river (km) affected

Annex 1b: Alternative Approach: Comparison of Method with Alternative (ECD) Approach:

The methodology used here for estimating the potential human health benefits of adopting water related Directives differs from that used by EDC et al (2000). Box C.1 summarises the results of that study. As discussed above in Section 2.1.1 and below in Section 2.4, we believe these results to be an overestimate. We have not been able to find any evidence that the mortality and morbidity figures used in EDC et al (2000) are associated with the current drinking water quality. Therefore the approach used in that report is correct, however, not applicable to the context of estimating benefits of adopting water related Directives in the candidate countries.

Box C1: Benefits of Avoided Water-related Disease as estimated in EDC et al (2000)

The WHO/EEA Monograph on Water Resources and Health in Europe undertook a survey of the incidence of the water-related disease across the WHO/Euro region. Although this is the most complete dataset to date, a robust estimate of the true burden of water-related disease is not possible and the estimates used in this study are put forward as very broad approximations in the absence of anything more accurate.

The Monograph presents data on the recorded incidence of gastrointestinal disease, typhoid (bacterial), amoebic dysentery (parasitic), giardia (parasitic), hepatitis (viral), bacillary dysentery (bacterial) and non specific gastro-enteritis (unspecified) in the WHO Euro region. The following steps are then taken for impact assessment:

1) interpolation to fill the gaps in the dataset for those countries where data is missing. As a first approximation this can be done on the basis of the incidence reported in neighbouring countries.
2) an allowance must be made for the level of under-reporting. It can be assumed for the less severe outcomes that under-reporting occurs at least on the same level as in Western European countries.
3) some assumption needs to be made regarding the level of disease that is avoidable through investments in water supply and sanitation. On the basis of available literature, between 60% and 70% of cases can be assumed to be avoidable by the provision of ‘safe’ drinking water (interpreted as meaning compliance with the standards laid down in the Drinking Water Directive)
4) some assumptions need to be made about the number of cases that would involve premature mortality. Mortality rates from the general literature are assumed to apply.

The next step of monetary assessment is based on the estimates of cost-of-illness for some of the illness (morbidity) of concern here. These estimates are taken from the literature and adjusted using income elasticity of demand. The cost of mortality is expressed as VOSL – again as taken from the literature and adjusted using income elasticity of demand. The results are reported below.

Country	Benefits of avoided morbidity (MEUR)	Benefits of avoided mortality (MEUR)	Total benefits (MEUR)	Benefits per capita (Euro)
Bulgaria	139	62	202	24

Czech Republic	162	27	189	18
Estonia	23	9	32	22
Hungary	203	50	253	25
Latvia	41	23	64	25
Lithuania	39	33	72	19
Poland	686	279	965	25
Romania	356	246	603	27
Slovak Republic	73	19	92	17
Slovenia	84	22	106	53
AC10	1,806	770	2,577	24

THE BENEFITS OF COMPLIANCE WITH THE ENVIRONMENTAL ACQUIS FOR THE CANDIDATE COUNTRIES

PART D: WASTE MANAGEMENT DIRECTIVES

PART D: WASTE MANAGEMENT DIRECTIVES

Contents

ANNEXES

THE BENEFITS OF COMPLIANCE WITH THE ENVIRONMENTAL ACQUIS FOR THE CANDIDATE COUNTRIES

PART D: WASTE MANAGEMENT DIRECTIVES

PART D: WASTE MANAGEMENT DIRECTIVES

This section presents the detailed assessment of the benefits of implementing the waste directives. As with the Parts B on Air and C on Water, Part D is split into three parts: a qualitative assessment of the benefits; an assessment of the extent of the benefits; and an estimate for the value of the benefits, in monetary terms.

Each of the three tiers should be seen as important assessments in themselves, and not just as a route to the final monetary assessment. While this is true for the assessment of the benefits for air and water, it is especially so in the case of waste, given the limitations on what can actually be valued in monetary terms.

Table D1 provides an overview of the type of analysis that was possible for the various directives within the context of this study. Importantly, the methodological limitations and limitation of data availability have led to only a sub-set of the directives being assessed up to the monetary level. An assessment of the extent of benefits has been carried out for all areas where there is a monetary evaluation. In addition, some quantitative data is presented in the qualitative discussions. Details on which aspects were assessed at each stage are presented in the subsequent sections below.

Table D1: The Acquis Communautaire, and Level of Analysis

Directive		**Level of Analysis**
C. Waste Management		
Framework Directive on Waste	75/442/EEC amended by 91/156/EEC, adapted by 96/350/EC	Qualitative analysis
Titanium Dioxide + daughters	78/176, am. 82/883, 92/112 etc.	General description
Air pollution: incineration of waste	2000/76/EC (replacing 89/369/EEC, 89/429/EEC, 94/67/EC)	Monetary assessment
Landfill	1999/31/EC	Monetary assessment
Disposal of Waste oils	75/439, amen. 87/101/EEC	Qualitative analysis
Disposal of PCBs and PCTs	76/403/EEC amen 96/59	Qualitative analysis
Hazardous Waste	91/689, amen. 94/31/EC	Qualitative analysis
Sewage Sludge and Soil	86/278, amen.	Qualitative analysis
Batteries and Accumulators	91/157, amen. 93/86/EEC	Qualitative analysis
Packaging waste	94/62, amen. 97/129/EC	Monetary assessment
Toxic and Dangerous Waste	78/319/EEC	Qualitative analysis
Animal Waste	90/425/EEC, 90/667/EEC	Qualitative analysis
Control of Transboundary Movements of Haz. Waste and their Disposal	93/98/EEC	Qualitative analysis
Supervision & Control of Shipments of Waste	94/575/EC, 94/774, 96/660/EC	Qualitative analysis

Note other areas have been explicitly excluded altogether from the sub-study. These include: Hazardous Waste List (94/904/EC); European Waste Catalogue (94/3/EC); Regulation – Shipment of Waste (EEC/259/93).

It is important to note that the selection of directives does not suggest that the benefits for the directives not selected are insignificant. Nor does a lack of monetary analysis suggest that there will be no significant value of implementing the directive in question; it simply means, as stated above, that there is insufficient data to carry out such an evaluation sensibly and be able to come out with robust and defensible answers.

1. QUALITATIVE ASSESSMENT OF THE BENEFITS OF COMPLIANCE WITH THE WASTE MANAGEMENT RELATED DIRECTIVES

As with the qualitative analysis of the benefits of implementing the air and water related directives (Parts B and C), the discussion on the qualitative benefits of implementing the waste related directives covers more directives and benefits than the subsequent chapters on the extent and value of the benefits. The aim of the qualitative analysis is to highlight and explore the range of benefits from each of the directives, and present country examples, where pertinent, of the benefits and their context in the countries. Generally only a sub-set of country specific examples are presented for each benefit type, and lessons from one country are clearly of relevant to some other candidate countries. This attempts to keep Chapter 1 to a more reasonable length. Further shortening could lose some country specific detail, and make the benefits qualitative discussion too general and reduce relevance for readers from across the candidate countries.

The implementation of the directives on waste will lead to major changes in the management of waste in candidate countries. They will affect the record keeping and regulation of waste handling, treatment and disposal at existing and new sites. The nature of treatment will also change for specific waste streams as a consequence of the directives.

Because of the many directives that exist, and because they frequently leave the path of waste management open to the Member State[1], it is not always easy to identify exactly what will occur as a consequence of implementing a specific directive. Hence, the nature of benefits tends to be relatively 'open-ended' and contingent upon the state of play today, and (for obvious reasons) the extent to which the status quo is required to be altered by the content of the directives.

To some extent, it may be more simple to identify benefits associated with the implementation of a set of directives, reflecting the fact that the best strategy for the ACs will be to review waste management practices in the round rather than on a directive-by-directive basis.

Generally, directives ask for one or more of:

- Improved record-keeping for specific waste streams, with the aim of improving the audit trail for harmful wastes;

[1] And through the accession process to the Candidate Countries.

- Improvements/upgrades of treatment technology: these lead to relatively unequivocal benefits, though the magnitude of these benefits is dependent on the existing standards applicable to treatment technologies in question. It might be assumed that the greater is the change, the greater is the benefit.
- Changes in waste treatment: generally, the directives promote movement up the waste management hierarchy. The benefits associated with such changes are dependent upon the emissions associated with the different treatment routes. In relatively few cases are the changes known to lead to 'vector superior'[2] situations in respect of emissions, but there may also be benefits to be gained from conserving resources (though the emissions reduction and the resource conservation benefits may occur outside the country where the directive is being implemented);
- Prohibition / phase-out of certain wastes: direct benefits are assumed to be positive though net benefits may depend upon the substitution of these pollutants by others arising from changes in processes / products used. Evidently, the benefits to a given country are dependent upon the extent to which these pollutants are being produced today.

This section explores the following directives in detail:

- The Framework Directive on Waste (75/442/EEC as amended by 91/156/EEC) (Section 1.1)
- Landfill Directive 1999/31/EC (Section 1.2)
- Packaging Waste, 94/62, Amen. 97/129/EC (Section 1.3)
- Air pollution: incineration of waste (replacing direct. 89/369/EEC, 89/429/EEC, 94/67/EC) 2000/76/EC (Section 1.4)
- Hazardous Waste, 91/689, Amen. 94/31/EC (Section 1.5)
- Disposal Of Waste Oils, 75/439, Amen. 87/101/EEC (Section 1.6)
- Sewage Sludge And Soil, 86/278, Amen. (Section 1.7)
- Batteries And Accumulators, 91/157, Amen. 93/86/EEC (Section 1.8)
- Disposal of PCBs and PCTs, 76/403/EEC Amen 96/59 (Section 1.9)
- Titanium Dioxide + Daughters, 78/176, Am. 82/883, 92/112 EEC etc. (Section 1.10)

[2] By 'vector superior', we mean superior in its performance with respect to every pollutant. Since different pollutants have different (more-or-less location-specific) impacts, it is not generally possible to say what is 'best' without closer analysis of the trade-offs (which is where economic analysis has at least something to contribute).

1.1 Framework Directive on Waste

The Framework Directive on Waste (75/442/EEC as amended by 91/156/EEC) sets out the legislative framework for waste at the Community level. Article 7 of the Waste Framework Directive (75/442/EC as amended by 91/56/EEC) requires Member States to prepare plans to ensure the directive's objectives are achieved.

More generally, the candidate countries will have to ensure that waste management plans reflect the requirements of the Hazardous Waste Directive (91/689/EEC) and the Packaging Directive (94/62/EC), as well as the requirements of Article 5 (Para 1) of the Landfill Directive.

Another important aspect of the Waste Framework Directive is that it sets out the requirements for permitting (licensing) of waste management facilities. It differentiates between disposal and recovery activities through reference to Annexes II A and B, respectively. Recovery activities are encouraged under the Article 3. The directive requires all disposal activities to hold 'a permit' (Article 9). It also stipulates that any establishment or undertaking carrying out recovery activities as listed in Annex II B should obtain a permit (Article 10), but Article 11 lays down exemptions from permitting requirements.

1.1.1 General Statement on Benefits

The extent of any benefits accruing as a consequence of implementation of this directive are clearly related to the degree to which existing and future patterns of waste management give rise to concerns in respect of their impact on the environment and human health.

The benefits of compliance relates not only on the impacts of current waste management practices on health and the environment, but also on the way in which the candidate countries seek to implement the directives. The objectives can be met by different implement paths, for example the landfill directive can be in part met by either increased recycling and composting or with increased incineration. Furthermore, the national choice for how to balance measures within the waste management hierarchy (minimisation, re-use, recycling/composting, recovery, disposal), will affect the benefits; in general the higher up the hierarchy, the larger the benefits. These benefits are therefore difficult to predict, and a scenario approach for different waste management strategies is the best option for assessing the benefits (see later sections discussing the maximum recycling/composting scenario and the maximum incineration scenario, to take two options).

As this section focussed on the Waste Framework Directive, many of the benefits discussed will also be of relevance to other directives (e.g. Landfill Directive); indeed for many of the benefits to arise, implementation of the set of inter-related directives is often needed.

1.1.2 Health Benefits

Closer monitoring and stricter permitting of disposal practices are likely to bring benefits to human health and the environment. This is not only the case for (non-compliant) existing sites, but also for future waste management sites where better regulation should promote consideration of factors such as hydrology, atmospheric conditions, geology, etc. to encourage more responsible placements with associated health benefits.

Landfill: Landfill disposal (see also later discussion on the Landfill Directive) can pose problems to public health:

- Improper lining of the landfill can allow leachate to contaminate ground and surface waters, putting local populations at risk;
- Landfill gas leaks can cause explosions on site, endangering workers. Dioxins can be released from waste combustion on sites;
- Landfill sites attract rodents (rats), which can be vectors for disease.
- The transport of waste to landfills can lead to air and noise pollution;
- Disposal of hazardous waste to landfill is often unrecorded and unregulated – creating not only serious risks in the short term but also long term, often irreversible problems.

Better monitoring and regulation can address these problems by making current practices transparent, highlighting potential and existing risks, and allowing them to be improved. This is likely to give rise to health benefits in terms of reduced mortality and morbidity rates.

Incineration: Similar benefits will accrue from better regulation and associated improvements to other disposal practices such as incineration where proximity to high populations poses health risks in terms of dangerous emissions to air, land and water.

Illegal Disposal: Illegal disposal is a common problem across the candidate countries. It is often carried out close to population centres and in poorly prepared sites. The sites are often shallow with no lining and the waste is often exposed to air for long periods of time. This practice causes health risks in terms of emissions to air as well as to surface and ground waters. The sites can also attract rodents and insects with associated risks of disease. Illegal disposal is often carried out directly into the sea, which poses health risks for local food sources and recreational activities. While improved regulation is likely to increase disposal costs (which might increase illegal disposal), better monitoring should make the final disposal destinations of waste more transparent; increased diversion should reduce the need for illegal dumping. Reduction of illegal disposal is likely to be associated with health benefits.

In addition, the reference to best available technologies suggests a positive influence on health across all waste treatment practices in the future. It should reduce harmful emissions to all media that come into contact with local populations. The degree to which plans always reflect this is in practice is however difficult to discern.

Lastly, the requirement for an ‘integrated network’ of installations suggests that where transport distances are currently excessive, they might be reduced. This would reduce unnecessary harmful air emissions, increase safety from transport related accidents, and reduce noise and disturbance. In practice, once again, the degree to which the ‘proximity principle’ is rigidly adhered to is at best uneven, and probably reflects more pragmatic (and historical) decisions concerning the siting of treatment plants.

Specific benefits likely in candidate countries include:

- In Bulgaria disposal practices are often unsafe, and not monitored. With a few exceptions, landfills do not comply with the new requirements. Almost every human settlement has one or more illegal disposal site and the majority are not controlled.

- Currently Cyprus has no general law on waste management and only has a number of general principles. It is considered imperative that a separate law on waste management and adequate national regulations are elaborated and adopted. Implementation of these will lead to associated benefits for health and the environment.

- In Latvia at present, waste collection services are not available to all inhabitants – up to 20 per cent of the population in large towns and cities and up to 80 per cent in rural areas do not have any waste collection services which means unregulated dumping is widespread. Implementation will result in the establishment of 10-12 regional landfills for municipal solid waste and closure of existing landfills and dumps that cause pollution of surface and groundwater.

- Malta lacks a comprehensive national policy/strategy that sets out the Government’s objectives, intentions, specific targets and related performance indicators for the management of wastes. This means that current waste management is largely uncontrolled. With the implementation of the directive, many environmental impacts and risks will diminish – for example dioxins emitted from the spontaneous combustion of waste at Malta’s main landfill site at Maghtab will be reduced. This will have positive impacts on landfill site workers who work on site as well as the residents and tourists living in nearby areas (e.g., Maghtab, Salina, Bugibba).

- In Poland there will be benefits from improving waste management, i.e. ensuring that toxic wastes will not be deposited together with other wastes categories. There will also be a reduction in illegal waste disposal, which has important impacts on human health.

- In Romania current practices of co-disposal of wastes, on insufficiently or uncontrolled sites, often located near residential or recreation areas, are among the highest risk for health, soil and water pollution.

- The waste management system in the Slovak Republic is one of its most under-developed areas. Positive health impacts are expected from implementation. Improvement is anticipated in landfill management and related law enforcement. In 1993 there were 7,204 landfills, when only 335 (including 128 landfills containing dangerous waste) of them were legally registered. As a result of landfill registration, which was performed in 1992 and 1993, 8,372 waste dumps have been listed. Until 1995 almost 1,500 illegal landfills were closed, and partially re-cultivated. It is clear that waste management in the Slovak Republic is still relatively uncoordinated, leading to many of the health risks outlined above. Increased regulation and monitoring will enable further identification of illegal sites, encouraging better management and re-cultivation.

- Current disposal practices for waste management in Turkey are unsafe for the majority of the municipalities. In 1994, the statistics indicate that the average amount of municipal solid waste per capita was around 1.1 kg/day (total for 1994 is given as 17.6 million tons). Integrated networking is a new concept and it is only at the conceptual phase in some greater municipalities such as Istanbul, İzmir and Bursa. There are only a few sanitary landfills in operation. Recycling activities are executed mostly by scavengers and very serious health problems exist for these people. In Istanbul about 39 people working/living at the Umraniye – Istanbul "wild-dump site" died because of a mudslide. Proper closure and remediation activities are needed for several active sites throughout the country.

- In Hungary approximately 37% of municipal solid waste (MSW) is disposed of in a controlled way and 63% in an uncontrolled manner (1998). According to the Hungarian Ministry of the Environment, about 100-200 regional landfill sites operate in Hungary, alongside some 2,500-2,600 unregistered dumping. A very limited number of landfills are designed and operated according to modern standards and specifications. Increased regulation and reduced illegal dumping would therefore bring substantial health benefits.

1.1.3 Ecosystem benefits

The Waste Framework Directive requires that waste management facilities are located so that new environmental problems are avoided. As described above, current disposal practices often put ecosystems at risk. Emissions of toxic leachate to ground and surface waters from landfill sites, as well as numerous hazards to terrestrial and marine ecosystems from illegal dumping can incur significant costs to the local environment. The interconnectedness of these ecosystems means the toxicity has far reaching effects. Many of the benefits connected with compliance outlined above are also therefore relevant to ecosystems.

Specific benefits likely in candidate countries include:

- Implementation of the waste directives in the Czech Republic in general could have considerable benefits for the protection of groundwater, surface water, air, soil and vegetation due to the stricter requirements for waste management, and hence benefit eco-systems. According to the statistics, 26% of municipal waste is unreported which presumably means that it is stored in illegal disposal sites. After implementation illegal dumping should become less of a problem.

- Cyprus has 5 known landfills for municipal solid waste (MSW), operating currently in Nicosia, Limassol, Larnaka, Paphos, and Paralimni. Only 75% of the population of Cyprus are served by these landfills. The other 25% (mainly in residential rural areas) dispose of their waste in an uncontrolled way in riverbeds or cliffs with associated environmental problems. These will be addressed through regulation.

- In 1997, 558 waste dumps were operational in Latvia, where household, institutional and industrial waste was disposed. They have been constructed without any environmental protection facilities, e.g. without waterproof liners, and therefore implementation and subsequent site management will benefit the local environment.

- The landfills in Malta and Gozo receive all kinds of waste, including hazardous wastes, and over the years have lead to significant environmental impacts and risks from pollution of air to leachate eventually entering the nearby marine environment. Should Malta adopt the option of using waste as a source of energy, this will have indirect benefits by reducing energy demands from other sources (power stations) resulting in lower emissions.

- In 1998, there were more than 314 landfills for municipal waste disposal in Lithuania. On the whole, these were poorly designed and constructed. The majority of existing landfills are unlined or are only partly lined and either lack a collection system or only have a collection system where leachate are stored in lagoons with no further handling. Only a few landfills have facilities to treat leachate or are connected to a sewerage scheme. Many landfills are located in abandoned gravel pits where there is a high risk of direct hydraulic contact with groundwater resources. The lack of effective leachate management leads to ground and surface water contamination. As described above, leachate poses risks to local ecosystems that rely on the contaminated water as a drinking source and living environment.

- 99% of waste in Estonia is currently landfilled. Landfill sites are not managed efficiently and result in anaerobic waste degradation, formation of waste gas, and seepage into surface and ground water.

- In Slovakia illegal landfills disturb natural ecosystems and implementation of this directive should prevent this activity. More pressure on recycling and waste minimisation will mean less waste production (or at least slow down) and hence fewer negative impacts on ecosystems.

- There are known to be a large number of illegal dumping sites in Slovenia. Many of these illegal disposal sites are likely to have profound impacts on their natural environment, from emissions to all media. Better regulation, and an associated decrease in illegal dumping, would result in benefits to local ecosystems as described above.

1.1.4 Social Benefits

Many of the possible benefits to candidate countries, stemming from the Waste Framework Directive, are connected to the health benefits described above. Better regulation and monitoring is likely to lead to an increased amenity for the local population. This could include improvements in odour control and aesthetics, as well as an increased understanding of local waste management issues.

As described above, the encouragement of an “integrated network” of waste management installations should lead to a decrease in transport requirements with associated social benefits such as reduced congestion, noise and improvements in air quality.

A reduction in illegal dumping could bring substantial benefits as dumpsites often create odour and aesthetic problems, and attract rodents and other scavengers to the area.

1.1.5 Wider Economic Benefits

By encouraging practices further up the waste management hierarchy, the directive should stimulate resource use efficiency, the recovery of materials and the recovery of energy. In practice, it is not clear that it has the legal force to do this (hence the steady introduction of other directives with these purposes in mind).

To the extent that it does do this, however, there are a number of possible benefits to the candidate countries. Recovery of materials will lead to a decrease in the demand for primary production that, to the extent that it is imported, will stimulate an increase in local competitiveness. It is also likely to create employment opportunities, associated with collecting, recovering and recycling secondary materials. Recovery of energy will lead to a decrease in demand for energy generation from other sources.

Encouraging the use of best available technologies has the potential to stimulate local technological markets that in turn has the potential to increase both employment and competitiveness in the long-term.

To the extent that compliance with this directive will lead to waste minimisation, this will have wider economic benefits in terms of reducing the requirement for additional disposal capacity. In terms of reduced future landfill capacity, this would have otherwise displaced potentially more profitable land-uses. In terms of constructing other waste treatment plants, a reduction in the need for additional capacity could lead to substantial cost savings.

On the other hand, some countries may see any attempt to impose waste minimisation policies upon them as an attempt to hold back economic growth. This raises important issues about resource productivity and the need to de-link waste production from economic activity.

Specific benefits likely in candidate countries include:

- The Maltese Islands have a total area of approximately 316 km^2 and a resident population of 376, 335 (in 1995). This coupled with an expanding population and increasing tourist arrivals renders land a precious resource. The adoption of waste recovery techniques leads to reduced volumes of waste entering the landfill site, implying less land taken up for landfilling and more land released for development. Furthermore, if waste were better managed there would be less contaminated land requiring expensive rehabilitation, releasing funds for alternative use.

- In the Czech Republic, only 8% of municipal waste is recycled. The implementation of the directive will help to launch new recycling facilities.

- In Bulgaria at present, collected data on waste management as it appears in the State of the Environment report, is often incomplete. Implementation would address this with subsequent benefits in terms of better-informed future waste management plans.

- The existing landfills in Cyprus are not constructed according to modern standards e.g. they have no protective measures regarding leachates. Implementation and subsequent regulation will focus upon the standards of the landfills and the need for protective measures. This will safeguard for example, the limited water resources of Cyprus against contamination, protecting a precious and expensive resource.

- In Poland increase in waste recycling should open the market for new firms that will be involved in this activity. Implementing the waste hierarchy should also help in generating new recycling and composting facilities. Polish environmental law presently does not require waste management plans, though a new act is addressing this. The Waste Framework Directive will help promote a better understanding of the actual waste management situation and lead to development of waste management plans in the future.

- In Slovakia, waste recycling and energy recovery positively influence the economy of enterprises.

- In Turkey new industrial sectors will emerge due to the introduction of EU waste directives. Waste collection and landfill operation companies will develop and privatization activities will expand in this sector, which at the present is mostly managed by public (municipal) groups. Also new and modern recovery and recycling facilities will be established.

- Municipal waste in Slovenia is primarily deposited in some 53 landfills (from which 37 are not in line with EU requirements). Specifically, many of the existing landfills operate without proper documentation or have no legal status. Some of them have already been closed down and others will have to be adapted or closed down, according to new waste disposal national legislation (and EU directive), in the next few years. These landfills occupy a total area of around 365 hectares and will soon be full. Waste minimisation will reduce the need for increased landfill capacity with associated economic benefits of displacing other, more profitable, land uses.

1.2 Landfill Directive

The Landfill Directive (1999/31/EC) includes a number of measures designed to reduce emissions from landfill, and also to rationalise the process by which wastes are managed through landfilling. The directive has a number of implications, of which the most important are:

- Article 5 Targets to divert biodegradable municipal waste from landfill
- Requirement to reduce all biodegradable waste sent to landfill
- New classification of landfills (end to co-disposal – classification into inert, non-inert and hazardous)
- Bans on landfilling of tyres, liquid wastes, infectious clinical wastes, explosive wastes and flammable wastes
- Requirements for pre-treatment
- Financial provisions
- Capture of landfill gas for flaring recovery

Although this directive has now entered into force, none of its details have been properly 'tested'. What will be implied by pre-treatment, and how different landfills will be categorised into inert, non-hazardous and hazardous is not yet clear and may vary between Member States.

1.2.1 Health Benefits

The health benefits from diversion of material from landfill are dependent upon how the existent landfills are managed, as well as the way in which 'diverted' wastes are treated as a consequence. Many of the health benefits from improved management of landfills have been explored in Section 1.1.2.

Another main aspect connected with the improved management of landfills, stipulated by the Landfill Directive, involves capture of landfill gas. This will have a number of impacts on health; not all of these impacts will be beneficial however. Landfill gas leaks have the potential to cause explosions, putting at risk the health of workers on site. Capture will increase their safety. The landfill gas, after capture, is then either flared off or combusted to generate energy. This process will reduce emissions of methane, and its associated impacts on climate change and the ozone layer with associated beneficial health impacts. However, the combustion process also gives rise to harmful air emissions such as dioxins. The direct impact of such emissions on human health is widely contested and therefore we cannot say whether these negative impacts override the positive ones. If the gas collected is used to generate energy, this may (under certain assumptions) be taken to offset other polluting emissions associated with alternative energy sources with associated reductions in health impacts (examined and valued in the quantitative assessment). This, however, is a controversial basis for justifying the environmental case, since it is more a statement about prevailing energy policies than about the desirability of landfill gas utilisation per se.

Co-disposal of waste to landfill has associated health risks connected with improper regulation and management of hazardous waste that could have health impacts for the local population and workers on site. Reducing co-disposal will therefore have positive health impacts.

Diversion from landfill of biodegradable municipal waste will also have a number of impacts on health. These will vary across the candidate countries as they can comply with the Article 5 targets of the Landfill Directive in a number of different ways. The reduction of waste landfilled associated with diversion, irrespective of approach to compliance, will bring health benefits, many of which are outlined in Section 1.1.2.

To the extent that waste is re-used or recycled, the impacts upon health will be positive. There are limited health risks to workers involved in waste sorting and recycling but these are comparable to risks in other industries, which these secondary materials replace the need for. Increased use of secondary materials will replace primary production. This has health benefits resulting from reduced emissions of harmful pollutants to all media. Recycling and recovery levels are comparatively low across all candidate countries at present and so the extent to which these States choose to meet Article 5 targets by encouraging recycling and recovery, it is likely to bring substantial benefits.

At present the situation is less clear for incineration. Air emissions may cause health risk to local populations. This will be offset to some extent however by benefits from energy generation replacing other sources (as outlined above). This is examined in more detail in the quantitative section. The case is also not clear concerning composting, simply because of the lack of detailed analyses of the relevant effects. The impacts are likely to be beneficial however because of the potential replacement of primary production of fertilisers by secondary compost.

The extent to which the Landfill Directive encourages waste minimisation will lead to associated benefits of reduced disposal. These benefits have been explored under the Waste Framework Directive (Section 1.1.2).

Specific benefits likely in candidate countries include:

- In the Czech Republic a relatively large amount of waste is produced - a total per year of around 52 million tonnes (including a high proportion of hazardous wastes - however this fraction is affected by the stricter parameters for classification of this waste). The predominance of landfilling is reflected in the fact that about 21 million tonnes of all kinds of waste were deposited in landfills in 1996. Therefore general minimisation and diversion from landfill are likely to bring health benefits. A low proportion of waste is used as a source of secondary raw materials and energy at present, bio-waste from households is only collected separately in 3 Czech cities. Increased recycling, if adopted to comply with the targets, would bring health benefits. There are no significant landfill gas capture facilities at present but such facilities are expected to be installed as the directive is implemented.

- Landfill is the dominant method of waste disposal in the Maltese Islands handling the majority of MSW, industrial and commercial waste, healthcare waste as well as construction and demolition waste. Both the Maghtab and the Qortin landfill remain largely "uncontrolled", due amongst other things to co-disposal of hazardous and non-hazardous wastes. Malta is currently evaluating its waste management options, however it seems that landfill will continue being the dominant form of waste disposal. The implementation of the directive will have several important health implications for workers on site and surrounding residents and tourists. This is of particular concern in view of the proximity of the Maghtab landfill to the popular recreational area of Bahar ic-Caghaq. Expected benefits include:
    - Reduction of landfill gases (eliminating explosions in the landfill);
    - Reduction in the number of vectors, insects and rodents that besides being a nuisance are carriers of disease
    - Reduction in groundwater pollution

- In Turkey, nearly all landfills (98%) are uncontrolled sites and of a mixed character (where urban and industrial wastes are being deposited together). Implementation would lead to benefits associated with increased regulation and reduce the risk of co-disposal of hazardous and non-hazardous waste. Proper closure and remediation activities are needed for several active sites throughout the country. Mix dumping of household wastes with clinical and hazardous industrial wastes creates great concern for public health[3]. Mixing of the seepage water from the landfills into the ground water is yet another very important danger to the public health. Therefore introduction of the context of this directive will have important health benefits.

In Hungary, a large proportion of waste is disposed of in an uncontrolled manner. At present, very few landfill sites have modern specifications and therefore gas capture levels are very low if not non-existent. Waste minimisation would therefore reduce the need for increased waste disposal capacity thereby reducing future health risks.

- There are a large number of unlicensed landfill sites in Lithuania. Further regulation would lead to both health and environmental benefits.

1.2.2 Non-health exploitation benefits

These will depend upon the nature and extent of changes, which are likely to occur as a consequence of the directive.

[3] Total hazardous clinical and hazardous industrial waste is estimated to be 28 million tons.

Illegal dumping, especially of hazardous waste, can have a significant impact on the land-use activities surrounding the dumpsite. For example it can have negative effects on agriculture (by attracting rodents and contaminating ground water) and tourism (by creating odour and aesthetic problems). A reduction in dumping through compliance would therefore have associated benefits.

Some candidate countries seem likely to encourage composting to meet diversion targets. This involves the return of organic matter to the soil, which may improve yields (and possibly, product quality).

Energy from landfill gas will be captured and used rather than emitted into the atmosphere, which may be the norm at present. The risk of explosions from build-ups in landfill gas will also be reduced.

The ‘land-take’ from landfill may be reduced; though it should be pointed out that often holes are not dug up with the specific purpose to fill them with waste. The holes in the ground, which may become landfills, are usually the result of quarrying activities / salt mining etc. so the degree to which ‘land-take’ is affected will probably be limited (and indeed, it could be argued that reduced landfilling actually prolongs any disamenity associated with these sites). The extent to which land-take is reduced will vary across the candidate countries. Countries with substantial land pressures, without available additional capacity, are likely to benefit most considerably.

Specific benefits likely in candidate countries include:

- In Malta the area surrounding landfills consists of agricultural land. Food production suffers because rats, from the landfill, eat the crops. A better-managed landfill should reduce this impact and restore agricultural yields.

- In the Czech Republic in 1998, about 350 landfills were in operation[4], of which 65 landfills could be used for the disposal of hazardous waste. The decontamination and reclaiming of old landfills, whose operation was terminated for failure to comply with the legislation, continues to be a substantial problem; given inherent environmental risks. Compliance and the associated improvements in management can address these issues and help protect local activities surrounding the sites.

- In Poland about 25% of landfills are not fenced or supervised. In these cases, there is a high risk that waste (possibly hazardous) is illegally dumped. Compliance is likely to reduce the negative impacts of such illegal dumping, as described above.

[4] Many state of the art regional landfills have been built over the last few years, reducing future risks, and making significant progress with the implementation of the directive.

- In Romania landfills take up approximately 12,000 ha and this looks set to increase in the future. There are significant land pressures. Compliance would mean that the extension of land take up would be stopped, reducing the negative effects.

- In Turkey, encouraging waste minimisation and increasing the amount of composting through compliance will both reduce the amount to be landfilled and also improve soil conditions.

1.2.3 Ecosystem Benefits

Many of the possible health benefits to candidate countries from compliance examined in Section 1.2.1 above, also apply to ecosystems. For example, contamination of ground and surface waters poses a significant risk to both local and wider ecosystems, as does emissions to air of various pollutants.

Primary production of materials such as paper and fertiliser causes problems for ecosystems from emissions to all media, as well as the need for energy generation increasing these emissions yet further. Primary production also requires increased resource use, which often has negative impacts on ecosystems, for example in terms of logging and mining. Therefore the extent to which recycling and recovery (and the associated reduction in primary production) is chosen by candidate countries as the way to reach Article 5 targets, the impacts on ecosystems will be positive in a similar way as the impacts are positive on health.

Increased incineration, as a way of increasing diversion of wastes from landfill, may, however, pose potential risks to ecosystems by emitting pollutants into the air, water and ground via increased landfilling of hazardous waste. Combined with the Incineration Directive however, increased incineration will also lead to a reduction in the demand for energy, offsetting these harmful emissions.

Waste minimisation will bring about benefits to ecosystems by reducing the negative impacts associated with all waste disposal.

Specific benefits likely in candidate countries include:

- An important impact of this directive is the rehabilitation of the existing landfills. Currently, 20% of the waste generated in the Maltese Islands is untreated. This waste still has the potential to leach into the groundwater and eventually into the marine environment (since Maghtab is close to the sea). Rehabilitation of the site will reduce the leachate to the sea that has deleterious effects on marine life. Air pollution is expected to be reduced with the consequent beneficial effects on surrounding plant and animal life.

- In the Czech Republic the recycling and re-use of waste as a secondary raw material remains at a very low level. The management of communal waste continues to be unsatisfactory, with only about 4% disposed in some manner other than landfilling. This high rate of landfilling, combined with the generally poor management of landfill sites observed across the candidate countries, poses risks to ecosystems. Increased diversion and better management would bring benefits as discussed above.

- In Romania current practices, especially on permeable sites, produce soil and groundwater pollution. When landfills are situated on slopes, heavy rainfall can lead to pollution entering surface waters. Complying with the directive will reduce ecosystem problems - species leave the area, vegetation is reduced to that of degraded areas, ecological regeneration takes decades and would still not re-establish the initial biological balance.

- In Turkey a reduction of the use of raw materials through increased rates of recovery and recycling of glass, paper, wood and plastic products are direct ecosystem benefits.

1.2.4 Social Benefits

Compliance with the directive will have important impacts on disamenities from poorly managed landfill sites, which are found in great number across the candidate countries. These benefits will be similar to those social benefits from the Waste Framework Directive outlined in Section 1.1.4.

Better management and regulation will address problems for local populations caused by odours and aesthetics from illegal and poorly managed landfill sites.

Source separation schemes associated with increased recycling, would lead to a better understanding of waste management by local populations. An associated reduction in the levels of primary production may have impacts in terms of less extraction of resources such as timber with benefits to local communities.

Any waste minimisation which results from compliance will lead to social benefits associated with a comparative reduction in the necessary disposal land use, transport and demand for new waste treatment facilities.

Specific benefits likely in candidate countries include:

- In Malta the poor management of Maghtab leads to problems such as rats, negative visual impacts, odours, truck traffic, dust and noise rendering the area socially unacceptable. These effects also impinge on the social, physical and mental well-being of the neighbouring population. Maghtab is close to the coast (Bahar ic-Caghaq), which is a popular bathing spot for local people. The presence of rats in the areas renders it not only unhygienic but also dangerous. A better-managed landfill would reduce this problem, making the area more suitable for recreation.

- In Romania currently landfills produce visual discomfort, air pollution, changes of landscape, all of which are perceived negatively by the population.

- Since the beginning of the year 2000 in Slovenia, a new regulation came into force, according to which householders are obliged to segregate the biodegradable waste they produce and store it in separate containers. However, enforcement of this regulation has been rather lax. Improved encouragement of separation at source by consumers and public involvement in recycling will lead to not only a greater awareness of the impacts of consumption on waste arisings, and improved understanding of waste management, but also help contribute to social responsibility towards the environmental. This will also help contribute to a possible reduction in waste arisings in the long term.

1.2.5 Wider Economic Benefits

Many of the requirements stipulated in the Landfill Directive will lead to increased landfill disposal costs. This negative economic impact will be offset however by a number of positive ones. Increased disposal costs will place a greater emphasis on efficiency of materials use and waste minimisation, both of which will have positive economic impacts including a reduction in the need for increased capacity and collection intensity.

To the extent that recycling and source-separation of compostables results from the directive, there will be benefits through reduced primary production of materials such as paper and fertilisers and, to the extent that these resources are imported, there will be balance of payments benefits as imports are displaced by reuse.

While increased source separation and recycling leads to employment benefits, this can be offset, though not completely by reduced employment in manufacturing from primary materials (and here, the reduction will be relative to a counterfactual – overall demand may increase with no gross negative impact on this sector). Therefore the net impact on employment may still be beneficial[5].

Specific benefits likely in candidate countries include:

- In Romania, dumping of recyclable, useful materials, which cannot be recovered, is common. Increasing separation of wastes at the source and recycling would bring wider economic benefits, including the development of a recycling industry, currently only partly in place in Romania.

- In Czech Republic capturing of the landfill gas can be associated with economic benefits as the gas is converted to energy and sold.

- The price of land is very high in Cyprus and the vast majority of MSW is landfilled, creating significant pressures. Diversion from landfill will be a significant benefit of the directive in terms of disposal costs, as there is less demand for existing landfill capacity.

[5] The labour intensity of recycling is generally higher than the labour intensity of manufacturing primary materials.

- None of the current waste dumps in Latvia have any environmental protection facilities and no gas collection takes place. Therefore implementation and subsequent gas collection will lead to potential energy generation and benefits in terms of global warming (avoided global worming through avoided release of methane, one of the six Kyoto Protocol greenhouse gases).

- In Slovakia implementation of the directive should support recycling and waste prevention programmes. This waste recovery may increase employment and reduce the demand for primary production of materials. Minimisation will lead to a reduced demand for costly new disposal capacity.

- The local market in Slovenia absorbs recovered paper and cardboard and partly metal, while glass has to be transferred to Italy. Therefore increased recycling of the materials in demand is likely to lead to benefits discussed above while clearly markets for materials such as glass need to be encouraged further. There is no recovery of source separated biodegradable waste at present, however this may increase due to the directive with associated benefits from potentially higher employment and a reduced demand for fertilisers.

- In Turkey increased composting activities will create new business and promote better business practices. In addition, less will be spent on the purchase of fertilizers.

1.3 Packaging Waste

The Packaging Waste Directive (94/62, Amen. 97/129/EC) seeks to encourage separate collection, recycling and treatment of waste, with the treatment of packaging waste following the waste management hierarchy (the hierarchy in short suggests: reduce use; reuse, recycle, and treat appropriately). Articles 4 and 5 concern minimisation of packaging, and require Member States to take measures to 'prevent the formation of packaging waste'.

The key targets for recycling and recovery are set out in Article 6. These are summarised below:

- Between 50 % as a minimum and 65 % as a maximum by weight of the packaging waste (across a range of packaging materials – e.g. paper, cardboard, glass, aluminium, steel, and wood) will be recovered within 5 years after implementation.
- Between 25 % as a minimum and 45 % as a maximum by weight of the totality of packaging materials contained in packaging waste will be recycled with a minimum of 15 % by weight for each packaging material

Member States shall, where appropriate, encourage the use of materials obtained from recycled packaging waste for the manufacturing of packaging and other products. Also important are the 'essential requirements' aspects of the directive, which seek to lay out rules regarding the design of packaging, the quantity and hazardousness of materials (including heavy metals) used in terms of their suitability for reuse or recovery, including recycling.

1.3.1 Health Benefits

To a considerable degree, these depend upon the way in which packaging wastes are currently being treated. In general, across the candidate countries, the situation is that packaging wastes are simply disposed of instead of being recycled or recovered.

The targets for increased recycling and recovery set by the Packaging Directive is likely to reduce the amount of primary production of packaging required. This reduction could be due to both an increase in recovery and reuse of recycled packaging materials, as well as efforts by candidate countries to minimise the amount of packaging used and therefore the amount that needs to be recycled. The use of recycled packaging materials is also likely to replace primary production of other materials. This reduction in primary production will lead to health benefits such as from a reduction in emissions of pollutants to air, water and land.

These benefits may not accrue locally. What may occur is that primary materials which are imported are displaced by production of packaging / other products using secondary materials. Hence, the pollution displacement and associated benefits will not necessarily be confined to the locality.

Increased recycling also often leads to waste minimisation. An associated reduction in the requirement for new disposal capacity will have positive health benefits. Another potential benefit from increased recycling from the Packaging Directive, derives from the associated impact on candidate countries and their approach to meeting the Landfill Directive. Increased recycling of paper may lead to candidate countries encouraging recycling to meet diversion targets with associated benefits described above. This potentially applies to all the benefits sections under the Packaging Directive below.

Specific benefits likely in candidate countries include:

- In Poland the quantity of packaging wastes over the last ten years has rapidly increased, and most of them are dumped on the landfills. The directive will assist in reversing this trend.

- The Slovak Republic must establish concrete targets for waste and packaging waste reuse and recycling. Limits for heavy metals in the packaging waste will also be set. These measures will reduce contamination of the environment, and subsequently the risks to human health.

- In Turkey specific benefits are identified due to the fact that while the packaging materials are of inert character the ingredients used, for example, in printing can pose safety problems. The control and reduction of these into air, water and soil will bring direct health benefits. Provisions to control non-sanitary collection and disposal as well as to provide target values for recovery and recycling of packaging waste are indirect health improving steps.

1.3.2 Non-health Exploitation Benefits

Waste minimisation, likely because of the Packaging Directive, will have a number of benefits. As waste minimisation will reduce the need for additional disposal capacity, this will in turn reduce the possible negative impacts associated with disposal practice – generally landfill, the major disposal method across the candidate countries. Furthermore, a reduction in primary production of materials (due to replacement by secondary materials) would reduce the need for resource extraction (such as timber), which could be beneficial to local activities. Specific benefits likely in candidate countries include:

- In Malta the danger of fire in the landfill will be reduced given the reduction in combustible packaging being disposed in landfills – hence reducing the risk of toxic air emissions. This has beneficial effects on surrounding agricultural land. Furthermore, given the reduction in packaging waste going to landfill, the demand for new landfills will reduce and hence reducing the pressure on new land-take, leaving more land available for other uses, with ensuing benefits.

- Raw material policy in the Czech republic concerning minerals and its sources was adopted in 1999. Among others initiatives it aims to establish the enhanced support of major utilization of used materials and recycling, energy savings and major utilization of renewable energy sources. The reduction in raw material use is clearly an important issue to the Czech Republic. Implementation of the Packaging Directive, with associated reductions in primary production, will address this.

- In Poland large quantities of packaging wastes are illegally dumped in forests or in the soils, therefore implementation of the directive will reduce contamination of soils, forests, water etc.

- In Turkey some action to reduce packaging waste since 1991 has resulted in a reduction in “litter” especially in the tourist regions of the country.

- Currently, Slovenia recycles or recovers 29% of all packaging that becomes waste. This is significantly below the directive’s 50% target. To the extent that increased recycling brings benefits (as described above), compliance with the Packaging Directive targets will lead to increased benefits.

- The volume of domestic waste in Lithuania is growing noticeably due to an increasing use of food products’ and household goods’ packaging, particularly disposable packaging. There has been almost no sorting of waste so nearly everything has been dumped. Implementation of the Packaging Waste Directive would address this by dissuading the increased use of packaging, recycling packaging, and subsequently reduce the pressure for new dumpsites in the future (with associated benefits as described above).

1.3.3 Ecosystem Benefits

Refer to Section 1.3.1 (Health Benefits) because many of the beneficial impacts of compliance for health are also relevant to ecosystems.

In Turkey for example, nature reserves and areas which are under special environmental protection benefited and will benefit further from the reduction of “litter” and from the unhealthy decomposition of the packaging materials / ingredients.

1.3.4 Social Benefits

Any waste minimisation, resulting from implementation of the Packaging Directive, will have benefits in terms of a reduction in disamenity from the need for increased disposal capacity. Many of these factors are discussed in Section 1.2.4. Furthermore, sorting of waste at source, can lead to populations’ improved awareness of the relation of their activities and pressures on the environment, and can engender a deeper sense of social responsibility. Similarly, increased recycling often leads to a better understanding of issues relating to waste management, and often the environment and resource use in general. This will benefit local communities involved in source separation schemes. Furthermore, the recycling activities are very employment intensive (more so than disposal at a landfill site), and therefore there is likely to be some net job creation (see also Part F), offering social benefits as well as wider economic benefits.

Specific benefits likely in candidate countries include:

- In Turkey an improved environmental consciousness resulted from the educational and training activities related to the reduction, recovery and recycling of packaging materials. This was most visible with the programmes implemented at schools of younger ages. This resulted not only from insights from the activities themselves, but also as the educational system started to include discussion of the waste practices into its educational curriculum.

1.3.5 Wider Economic Benefits

Increased recycling may have a marginal positive impact upon economic efficiency (where recycling costs less than purchase of primary materials) and balance of payments (to the extent resources are imported), compared with primary production. Encouraging recycling systems may well benefit a number of candidate countries which have shortages of certain materials and have to import them from elsewhere, sometimes at great expense.

A reduction in the amount of packaging used and waste minimisation deriving from increased recycling and awareness of waste disposal will lead to a smaller demand for landtake and often costly new waste treatment processes (taking into consideration the demands of the Landfill Directive), again reducing the need for investment.

There is a potential increase in employment through implementation of collection / reprocessing / secondary materials manufacturing systems. This could be offset however by a reduction in the need for primary production (and therefore employment). The former is generally more labour intense and therefore there are likely to be net employment gains. Furthermore, given that in many countries the primary materials are imported, there will be larger national net employment gains. The final balance of benefits will depend on geographic factors. This is examined in Section 1.2.5.

Specific benefits likely in candidate countries include:

- In Malta there is expected to be employment generation from the implementation of collection schemes[6]. This is unlikely to be offset by reduced employment in primary production because of the limited manufacturing industry in Malta, and given the labour intensity of recycling.

[6] There is already a well-established bottle take back scheme in Malta that supports employment.

Specific benefits likely in candidate countries include:

- Current recycling technologies in Bulgaria are oriented towards certain types of wastes only - scrap metals, waste paper. Due to changing socio-economic conditions, a serious decrease in the quantities of these commodities available has been recorded since 1991. A lack of secondary materials has lead to waste import, currently one of the most serious waste problems in Bulgaria. In terms of waste imports, Bulgaria imports mainly paper from Germany and Austria (50-60,000t/yr). Implementation would address this issue, stimulating much higher rates of internal recycling and increasing the availability of secondary materials.

- In Cyprus municipal entities are responsible for waste collection, transport and disposal. Only a few recycling activities are in operation. These include recycling of cans (approximately 10%), and a bottle deposit system. Implementation will reduce the cost of disposal in the long-term as land is becoming increasingly precious and MSW arisings are set to increase.

- The development of the system for the collection of used packaging has recently started in Latvia. In 1997, used packaging (plastic, glass, ferrous and non-ferrous metals, cardboard) was already being recycled in several enterprises. According to a Cabinet of Ministers Regulation, money has been allocated for subsidies for recycling or re-use of environmentally harmful goods or products. Implementation will develop the system further and build on the infrastructure already in place to provide associated economic benefits such as reductions in disposal costs and raw material demands, as well as developing markets for secondary materials.

- In Turkey, the more the packaging materials are recovered and recycled, the more viable it is for recovery and recycling industries and markets for secondary materials to develop. Estimated quantities of packaging: paper/board, glass, plastics and metals are 590,000 (33%), 75,000 (23%), 180,000 (33%) and 50,000 (30%) respectively. The economy also benefits from a reduction in the primary raw materials used to produce these packaging products.

1.4 Air Pollution: Incineration of Waste

Essentially, the Incineration Directive (2000/76/EC, replacing 89/369/EEC, 89/429/EEC and 94/67/EC) regulates the emissions to different media of waste incineration plants. There is also a requirement to maximise recovery of energy in the new Incineration Directive. Furthermore, the directive actually requires an element of self-monitoring by plant owners requiring them to shut down operations to rectify problems where some limit values on emissions are exceeded. It is worth stating up front that basic mass-balance considerations suggest that where emissions to air are reduced, this usually occurs with an attendant increase in emissions to other media. Hence, the quantity of solid / liquid residues increases as air emissions increase. However, with appropriate disposal of the solid and liquid residues, significant net benefits will arise from the implementation of the directive.

1.4.1 Health Benefits

The health benefits from lowering incineration emissions are likely to be significant because target pollutants include particulates, heavy metals, dioxins, VOCs, CO, NOx, HCl, and HF. Lowering emissions of these will reduce the mortality and morbidity rates in the area surrounding the incineration plant as well as in the surrounding region (especially where health effects through NOx related ozone production are concerned).

For primary pollutants such as particulates and acid gases, the effects are likely to be more localised than for others (such as NOx) – given that the former "land" more locally than the latter. As such, some of the effects are closely related to the local population density whilst others are more dependent on patterns of dispersion across wider geographic areas. The dispersion pattern of pollutants will be affected by stack height, prevailing winds, and weight of the pollutant.

Completeness of combustion may be improved, increasing CO_2 emissions but with a corresponding reduction in CO. Lastly, it is frequently argued that energy from incineration 'displaces' other energy sources, and that since these displaced sources may generate more pollution, there is a net environmental gain. There are reasons to question this assumption (or at least, to question the assumptions made about which energy sources are being displaced). However, to the extent that the directive encourages energy recovery, it will lead to benefits from incineration relative to the 'no energy recovery' situation.

Specific benefits likely in candidate countries include:

- There are currently no municipal incinerators in Bulgaria, but construction is planned in Sofia and Plovdiv in the medium-term. These new installations will comply with the EU requirements in light of the Incineration Directive. Without the directive however, these new plants may have been built with poorer technological specifications (to save on cost) then required to meet emission limits under the directive. This is difficult to predict but, to the extent that these proposed plants would have had higher emission levels without the directive, there will be health benefits.

- In the Czech Republic the importance of incinerators as sources of pollution is affecting their immediate surroundings. The contribution of incinerators to the total pollution of the environment with dioxins is significantly higher than is the case for other pollutants. In the case of dioxins the Czech Republic law has no limits. If compared with the obsolete technology of most Czech incinerators and the total absence of dioxin filters, the dioxin emissions could be very significant. According to the EU dioxins limits only 36% of the Czech incinerators would meet the emission limit. An increase in the amount of dioxins in breast milk has also been observed. The implementation of the Incineration Directives will provide stricter emission limits leading to a lower impact on local inhabitants.

- At present there is one large-scale municipal waste incineration in Latvia but it is not used permanently for incinerating waste. One of the current proposals for meeting the Landfill Directive will be the construction of a large incinerator. Therefore implementation will provide future benefits to health and ecosystems in terms of lower toxic emissions and better regulation.

- Most of the existing incineration plants (four in Malta, one in Gozo) do not conform to the requirements of the directive. None of these facilities is equipped with gas cleaning systems. Air emissions such as carbon monoxide, particulates and heavy metals have negative impacts on the immediate surroundings of these installations. The introduction of this directive implies removal or upgrading of these facilities with consequent health benefits associated with reduced emissions of gases such as sulphur dioxide and nitrogen dioxide, which will lead to positive health impacts (less respiratory infections, etc.). In order to conform to the requirements of this directive other methods of waste disposal, such as microwaving, are being considered in Malta.

- In Poland waste incineration is not often used and usually new plants of that type increase public opposition. Therefore all new plants, which are built in Poland, are established based on the EU norms and standards. There is the only one municipal waste incineration plant in Poland, which complies with EU emissions standards. Considering medical waste incinerators the situation is not satisfactory at all. A lot of hospitals use their own small capacity incinerators without any emissions controls. A positive effect of implementation for health is expected because many incinerators are located in, or close, to city centers.

- In Romania there are currently five incinerators (Bucharest, Craiova, Iasi, Constanta, Timisoara). The feedstock wastes have a high percentage of organic components, and consequently a low caloric value. Implementation will improve the standards.

- In Slovakia, only 3.3% of the total amount of waste produced is incinerated in one of the 92 incineration plants. Out of these 92 plants, as many as 68 installations do not comply with the EU legislation concerning emissions (data as of 1998). Of the 34 industrial waste incinerators, 11 of them have no facility to trap exhaust gases. This figure is alarming especially in terms of heavy metals, and dioxins. A positive impact from implementation for health is expected to be significant because many incinerators are located in, or close, to city centers.

- Incineration is not on the immediate agenda of waste disposal methods in Turkey due to the composition of its waste as well as the investment and operational costs of these facilities.

- In Slovenia some hazardous waste is incinerated in smaller specialised incinerators - Lek, Pinus; some waste oils and tyres - Salonit Anhovo; and several industrial combustion facilities are used for co-incineration; there is no municipal solid waste incinerator yet available in Slovenia, although three proposals are in the pipeline - Kidricevo, CERO, Ljubljana. Upgrading existing incinerators and ensuring that future incinerators comply fully with EU legislation will help reduce emissions and provide associated benefits of avoided pollution impacts.

- In Estonia, while the principal waste treatment option is landfill, waste is also incinerated (both with and without energy recovery). Generally, current emission levels for some the pollutants listed above are above Directive limits. Therefore implementation will lead to benefits associated with a reduction in toxic gaseous emissions.

- In Hungary a single incinerator operates, in Budapest, with energy recovery, and a capacity that only covers part of the demand. It is about 12 years old and lacks modern emissions control equipment. Manual sorting of waste takes place prior to incineration, in an effort to control hazardous emissions. Implementation would address the health risks associated with emissions higher than the directive limits in such a high population density area.

1.4.2 Non-health exploitation benefits

The expected reduction in emissions of acid gases and ozone-forming pollutants (VOCs and NOx), due to the appropriate implementation of the incineration Directive, should improve agricultural yields and reduced damage to forests. Also, in the longer-term, the effect of more persistent pollutants such as heavy metals and dioxins may have an impact on soils and water, though the effects of these are not well understood in all cases, and the role played by dioxin is still subject to some dispute.

Certain pollutants such as particulates have a negative impact on buildings. Reductions in emissions of such pollutants will lead to reduced maintenance costs as well as amenity benefits.

Any reduction in the level of pollutants emissions to water due to the directive will have beneficial impacts on local water quality and hence reduce the burden on water utility services. It will also likely impact beneficially on local activities and industries where linked to river or marine environments.

Specific benefits likely in candidate countries include:

- Although the nature of emissions from the incinerator at the main hospital in Malta (St. Luke’s hospital) has not been investigated it is known to consist of particulates, carbon monoxide and heavy metals. In certain wind conditions these are deposited in the sea (Msida/Pieta area) leading to damage to marine life.

- Last Spring in Slovenia, two new regulations on incineration plant emissions came into force that weaken the levels and spirit of the previous regulations. While the new Slovene regulations on municipal waste incineration are "fully harmonised with the EU", acceptable emission levels are higher and some chemicals (like dioxin and furan) are not even regulated. Therefore implementation will reduce the emissions of pollutants where the Slovene limits are higher, leading to potential benefits outlined above.

- The impacts on agriculture, and especially forests, are important for Slovakia and a positive impact is expected.

1.4.3 Ecosystem Benefits

Many of the benefits to ecosystems, of reduced emissions from implementation of the Incineration Directive, are similar to those for health examined above.

Emissions of pollutants (listed above), to all media, will have negative impacts on both local and wider ecosystems. Because implementation is likely to limit these emissions, the directive should result in significant benefits to ecosystems.

Limiting emissions to air will improve air quality and therefore will have a positive impact on wildlife. Contamination of ground and surface waters can have significant negative impacts on local ecosystems (both terrestrial and marine), which then spread further because of the interconnected nature of these systems. To the extent that implementation limits these polluting water emissions, these ecosystems will benefit. Incineration creates hazardous waste, which requires safe disposal. As discussed previously, this might increase with the transfer of pollutants from other media. However, in combination with the Landfill and Waste Framework Directives (encouraging safe disposal), implementation should have limited impacts on ecosystems.

The emphasis on generating energy from waste may reduce the demand for energy generation from other sources. This will reduce the negative impact on ecosystems from these other sources (will depend on the source displaced as discussed above) due to, for example, reduced emissions to all media.

Specific benefits likely in candidate countries include:

- Currently most waste that enters the Malta and Gozo landfills is untreated. The introduction of incineration to treat waste will have positive impacts in terms of reducing the volume of waste entering the landfills and reducing its toxicity. This has positive ecosystem benefits through the reduction of air pollution (from combustion of waste at the landfill site) and sea pollution (from leachate).

- In the Czech Republic implementation will help with better assessment and monitoring of the following ecosystem pollutants: solid waste under the grate of the furnace, ashes from heat exchangers, solid dusty waste from dry filters, sludges of solid waste from wet filters, sludges of solid waste waster treatment, and active adsorbers of POPs. Regulating and controlling all these potential pollutants will have benefits for ecosystems.

1.4.4 Social Benefits

Better regulation and monitoring of incineration plants may lead to an increased awareness and understanding on the part of local residents of potential risks and opportunities. It may also improve the management of the plant, which could benefit local residents in terms of transport, odour and aesthetic issues.

The issue of aesthetics will very much depend on the action taken for compliance. Addressing issues of air quality may entail building higher flue stacks, which will increase the disamenity. As stated above however, there may be aesthetic benefits from better management however.

Potentially, lower cost energy for those living close to incinerators where the directive leads to energy recovery. However, this would most likely occur only where district heating systems were installed and the directive does not *require* this.

Specific benefits likely in candidate countries include:

- In the Czech Republic there are problems associated with access to environmental information. The amount of information released by the operator of the incinerators cannot be considered sufficient at all. New laws implemented will help local inhabitants with access to information and decision-making concerning incineration plants.

- In Slovakia there are problems because most of the current incineration plants are located in urban areas, e.g. Bratislava. When new technology will be implemented in the plant it will have direct positive impact on people living in the surrounding area (e.g. less odour, pollution).

1.4.5 Wider Economic Benefits

To the extent that the costs of incineration are increased (because of the costs of improving flu-gas treatment and emissions to water), there may be an increased incentive to valorise waste in other ways. This could lead to increased emphasis on recycling and composting with consequent positive effects on both employment and reduced primary production (examined above in Section 1.3.5).

The emphasis on lower emissions and associated technological improvements may stimulate local industry to meet this technological demand, which will have employment and wider economic benefits.

While higher costs may encourage other, potentially more beneficial, waste treatment processes, certain limited sectors where options are more limited may be negatively affected (for example infectious clinical wastes where there is a need for high temperature incineration). This may increase the economic burden on these sectors but the impact is likely to be minor compared with the other benefits outlined.

Specific benefits likely in candidate countries include:

- In Malta, under certain wind conditions, soot released from the chimney incinerator at St. Luke’s hospital settles on boats in the nearby Msida marina, sometimes staining them permanently. This negatively affects the marketability of the marina overseas. The adoption of high standards in incineration may lead to greater social acceptance of incineration. This can have long-term benefits for Malta in the siting of the facilities. Given Malta’s small size and limited availability of land for development, acceptance of incineration will lead to development in areas designated for development, rather than outside the development zone: making optimal use of land.

- In Slovakia implementation of the directive should support recycling and waste prevention programmes. This will eventually result in positive effect on employment and waste recovery.

1.5 Hazardous Waste

The Hazardous Waste Directive (91/689, amen. 94/31/EC) essentially concerns the handling of hazardous wastes and requirements for labelling and record keeping for such wastes. The directive itself as well as the Council Decision (94/904/EC) establishing a list of hazardous waste substances, defines the scope of the directive (by defining hazardous wastes).

1.5.1 General Statement on Benefits

The risks to both health and ecosystems connected with exposure to hazardous waste make its proper treatment and disposal a key priority. At present, the management of hazardous waste across the candidate countries in general is not well regulated and controlled. Though the directive concerns primarily the administrative tasks associated with dealing with hazardous wastes, it should lead to better monitoring and management of hazardous wastes that will give rise to benefits in a number of spheres.

There are obvious benefits to health for the surrounding population who are less at risk from contamination of ground and surface waters, as well as accidental exposure. Compliance therefore should lead to lower mortality and morbidity rates. These benefits are also relevant for terrestrial and marine ecosystems, which will benefit from reduced toxicity of their environments.

Because of the high risk associated with hazardous waste, contamination and accidental exposure could lead to costly clean-up operations in the local area as well as compensation of local populations. Compliance and the better management of hazardous waste in this case would help prevent such eventualities and the associated economic cost.

There are also likely to be amenity benefits connected with better planning of hazardous waste disposal sites and better management of existing sites.

Specific benefits likely in candidate countries include:

- In the Czech Republic implementation of the directive on hazardous waste might bring a benefit of lowering the risk of ecological accidents caused due to the improper waste management (like accidental discharge), since the EU legislation imposes higher requirements for the waste management. The duty to inspect periodically undertakings handling waste is not yet established. Plans for hazardous waste management are still missing in the Czech Republic.

- Currently in Bulgaria the capacity for the disposal and recovery of hazardous waste is insufficient and therefore the improper management of this waste poses risks. Compliance would address these risks as described above in this section.

- The total reported volume of hazardous waste generated in Lithuania during 1998 was 132 000 tonnes. Around half of the hazardous waste generated is oil/water mixtures. The second largest hazardous waste category is tannery waste with more than 9 000 tonnes generated each year. Another important group of hazardous waste is waste containing heavy metal, mainly plating sludge (approximately 900 tonnes produced annually). Each of the present risks if not dealt with appropriately, which implementing the directive will substantially reduce.

- In Poland it is believed that not all hazardous substances are properly managed, some of them can infiltrate to the environment and pose a hazard to human health and environmental protection. The situation improved in 1998, when the Waste Act was published – since this date plants producing hazardous wastes have to have special waste management plans and special administrative permission. Hazardous Waste Plans are drawn up by industries that produce more that 1000 tonnes of such waste. No such plans are presently required for smaller hazardous waste producers. The directive will force other producers to produce similar strategies for handling hazardous waste. Also firms, which are involved in hazardous waste utilisation, have to have administrative permission. Unfortunately hazardous substances are still not properly managed. The most important benefits will be connected with better control of hazardous waste circulation and utilisation.

- In Romania there are a total of 83 industrial waste deposits, on a total of approximately 450 ha. Out of these a limited number (about 25%) contain hazardous wastes. Only 10% of hazardous waste sites are licensed (1998). About 51,500 tonnes (2.75%) of all hazardous wastes were dumped on urban landfills, such as sludge containing heavy metals, oils, petrol and pharmaceuticals. Thus current management poses significant risk for health, etc and implementation of the directive is essential to remove these risks.

- In Slovenia, the reconstruction of existing tips, and construction of new ones complying with European standards, a higher standard of disposal and a substantial reduction in the hazard potential imposed on the environment will be achieved.

1.6 Disposal of Waste Oils

The Directive on the Disposal of Waste Oils (75/439, amen. 87/101/EEC) refers to any mineral-based lubrication or industrial oils which have become unfit for the use for which they were originally intended. The essence of the directive is to put in place a 'hierarchy' of options for dealing with waste oils. Regeneration of oils is to be given priority. Incineration of oils is to be carried out only in environmentally acceptable conditions, and where neither incineration nor regeneration takes place, safe destruction of controlled storage / tipping is to be ensured.

The directive established a need for a permitting system for those dealing with waste oils so as to ensure that no prohibited method of disposal takes place. There are regulations concerning the residues and the PCB/PCT content of the regenerated base oils, as well as limit values and clauses concerning the environmental effects and safety of processes using the oils as a fuel. There are monitoring requirements for those producing more than a specified volume of waste oils.

1.6.1 Health Benefits

The current methods of waste oil disposal across the candidate countries (to the extent that they differ from the directive requirements) pose a number of health risks. Disposal methods such as the emission of waste oils to sewerage systems can lead to the contamination of surface and ground waters, and hence local water supplies. Their improper disposal (to for example landfill sites) can cause soil contamination, which in turn can contaminate local food sources. Compliance will lead to better regulation and monitoring, as well as encouraging other treatment processes ahead of such disposal methods with associated health benefits.

The directive encourages regeneration above incineration. To the extent that this hierarchy is adopted by candidate countries, compliance will lead to health benefits in terms of reduced mortality and morbidity associated with lower air emissions of pollutants. Regeneration is also likely to replace primary production of oils which will give rise to health benefits related to reduced emissions from the life-cycle of 'oil regeneration' when compared with 'burning followed by extraction and processing of primary resources'. Relatively few analyses are available here (the European Commission is currently reviewing sources).

The permitting system is likely to reduce improper disposal as outlined above, as well as maximising health benefits associated with encouraging regeneration.

Specific benefits likely in candidate countries include:

- In the Czech Republic, the directive will create conditions for establishing effective systems based on the responsibility to return and re-use used mineral oils which might otherwise have been disposed of improperly.

- The re-generation of waste oils has been practised in Bulgaria for 20 years, though not comprehensively. Compliance with the directive will be met in terms of the regulation on the order of collection, storage and disposal of waste oils and oil products by the end of 1999. The National Waste Management Program presently provides facilities for the collection of oil. Health benefits will arise where the practice of regeneration can be adopted further. Better management of waste oils (in terms of collection, storage and disposal) will also give rise to health benefits.

- Approximately 500 tonnes of used lubricating oil were generated in Malta during 1997. This amount was generated from industrial sources, car service stations, and by private car owners who changed the engine oil. Most of this oil was either discharged into the sewer or collected and stored by a private company that was set up some years ago and which intends to convert used lubricating and edible oil into fuel oil. The company, however, encountered problems and the date for the start of operations could not be established. Oily wastes are therefore currently stored at a number of locations in Malta awaiting the completion of a waste oil separating facility. The bringing into force of this directive will imply that such facilities will become operational. This may bring health benefits in terms of properly treating the stockpiled waste oil whereas it might otherwise have been improperly disposed. Compliance will also reduce the illegal disposal to sewerage system and the associated health risks associated with contamination of water and soil environments.

- In Poland it is still not clear how 50 – 70% of the waste oil is utilised. It is probably discharged directly into water or municipal canalisation network. Therefore implementation of the directive should help to improve water quality, including those water resources, which serve the potable water supply.

- In Turkey direct health benefits of the Waste Oil Directive will occur by ensuring proper control of existing practices which result in dumping of the waste oils into the sewage systems, into non-sanitary landfills or burning them for heating purposes in small industrial zones.

1.6.2 Non-health Exploitation Benefits

Compliance may lead to both a reduction in landfill disposal of waste oils (encouraging instead other treatment processes) and an improvement in the methods of their disposal to landfill. Both of these impacts are likely to reduce the contamination of land and soils. This will lead to benefits to agriculture in terms of an improved quality and quantity of agricultural yields. Reduced contamination of land in general will benefit a number of land-use activities, especially in close proximity to population densities.

Encouraging regeneration is also likely to reduce primary production of waste oils. The reduced extraction of oil may have impacts on e.g. land and fisheries depending upon where this occurs and the degree to which controls are exerted over environmental impacts.

Improvements in disposal methods will also benefit e.g. fisheries in terms of reduced contamination of river and marine environments.

Specific benefits likely in candidate countries include:

- In Malta reduced disposal of oil at the landfill sites and at sea (through the sewerage system) has positive impacts on the quality of land and the marine environment. The latter is exploited for fisheries and aquaculture.

- In Poland the reduction of illegal old waste oil disposal to water should improve water quality, which will be important for fishing, agriculture and tourism. Most of the directive objectives have already been implemented – but not yet covering the full quantity of waste oil arisings. There is still the need for better management of waste oils. Plans exist for imposing deposit fees on waste oil and the associated revenue will stimulate development of the waste oil regeneration facilities.

- In Turkey a reduction in non-sanitary disposal (into uncontrolled dumps) will provide significant benefits.

1.6.3 Ecosystem benefits

Many of the issues surrounding contamination (described above) will also be important for ecosystems. To the extent that compliance leads to better management of waste oil disposal and hence reduced contamination of land, surface and ground waters; related ecosystems will benefit from a reduced toxicity in their local environments.

Replacing primary production by increasing regeneration will limit emissions of pollutants to all media with associated benefits for ecosystems. This depends however on the location of oil production.

Specific benefits likely in candidate countries include:

- In Malta implementation will have positive impacts relating to the disposal of oil in the marine and terrestrial environments.

- In Poland reduction of illegal old waste oil disposal to water will have direct positive impact for water ecosystems (inland and Baltic Sea).

- In Turkey current non-sanitary disposal clearly has the potential to mix hazardous materials into the ecosystem via seeping water into the ground water.

1.6.4 Social benefits

Compliance and hence a reduction in the contamination of surface and ground waters will lead to improvements in amenity connected with recreational use of both river and marine environments.

Improvements in the disposal of waste oils will lead to amenity improvements, depending on the current levels of improper disposal.

Reductions in the need for primary production (depending on its location) due to an increase in regeneration will reduce the disamenity associated with its production (e.g. buildings, transport). This will be offset however by the need for new facilities to increase the regeneration and incineration of waste oils, to the extent that these activities are encouraged by candidate countries under the directive.

There will be possible benefits by the potential generation of new industries / employment.

Specific benefits likely in candidate countries include:

- In Turkey presently very few companies have received permits to recycle used oils and large oil producers/marketers are active in forming an association for the management of the used oils on a regional basis. This is a clear indication of the growth of both environmental and social awareness. The associated need for individuals to collect waste oils separately and deposit at appropriate sites, increases the populations understanding of the environmental impacts of waste oil and engenders a sense of social responsibility.

1.6.5 Wider Economic Benefits

There may be balance of payments benefits associated with a reduction in the primary production of oils if the regeneration of waste oils is encouraged under the directive.

To the extent that the waste hierarchy laid down in the directive is encouraged by candidate countries, there will be benefits to employment in comparison with simple disposal. This will be offset however if regeneration encourages a reduction in the primary production of oils. This depends however in the location of this production. Specific benefits likely in candidate countries include:

- In Malta the oil recycling industry will generate on site employment as well as employment for collection purposes. Since all oil is imported, the possibility oil reuse can have important benefits in terms of reducing the fuel bill of the country.

- Reuse of recycled oils is an important economic activity for countries such as Turkey, since the oil imports drain most of the export income of these countries. Therefore, every (little) step in reducing oil imports has a powerful economic benefit.

1.7 Sewage Sludge and Soil

This directive (86/278, amen.) seeks to put in place measures to prevent harmful effects on soil, vegetation, animals and man, thereby encouraging the correct use of such sewage sludge. The directive sets out the conditions under which sludge can be applied to land. A principal aim is to prevent the accumulation of heavy metals in the soil, and this is to be achieved through setting limits on character of sludges applied, the amounts applied, and the nature of the agricultural enterprise to which different sludges can be applied. Article 5 is important in this respect. Note that the limit values specified in this directive are being re-considered.

1.7.1 Health Benefits

Compliance with the directive will limit the levels of heavy metals in sewage sludge applied to land. The main health benefits derive from attempts to minimise the heavy metal content of soils used in agriculture. Different crops, in soils of different pH, take up heavy metals to varying degrees. These are detrimental to human health. Therefore minimising the heavy metal contents of these soils will lead to health benefits from the consumption of the crop.

Furthermore, these metals may, unless they react to form stable complexes (which is unlikely in this case, though possible where lime is used – sulphates of heavy metals are insoluble), leach into groundwater and turn up in surface waters through run-off. This contamination is likely to lead to negative health impacts in terms of local water supplies and to the extent that local river and marine environments are used as sources for food.

Limiting the heavy metal content of sewage sludge applied to land may also have positive impacts on health for those involved in its application. Specific benefits likely in candidate countries include:

- Currently in Bulgaria there is no practice of using the sewage sludge in agriculture in Bulgaria. Sewage is currently used in the rehabilitation of mines, or is deposited at existing municipal landfills. The requirements of the directive will be transposed for treatment of sludge from wastewater treatment plants. Compliance will lead to benefits to the extent that both sludge from wastewater treatment plants is used in agriculture and sewage sludge is applied to land in the future[7].

- In Malta currently only 10% of wastewater is treated (at the Sant'Antnin Waste Treatment Plant, Marsascala). The sewage sludge is disposed of at sea. This practice has important health implications in terms of the content of heavy metals and the possibility of disease and infection from the contaminated sludge.

[7] Note that only sewage sludge not containing pollutants –e.g. heavy metals – above strict threshold values can be applied to agricultural land, so the benefits depend on the quality of the waste water and waste water treatment facilities.

- In Poland benefits will be limited because sludge is already used and managed for agriculture. Use is possible only when specific studies are undertaken, and that actions are positively assessed by Environmental and Sanitary Inspectorates.

- Introduction of this directive is very important for Turkey since it will provide scientific control of the sludge utilization as a soil improver.

1.7.2 Non-health Exploitation Benefits

The quality of agricultural produce will be improved. Any risk of harm to fish will be reduced, though the significance of this reduction is not well known. Accumulation of heavy metals in soils is prevented. Lastly, the benefits of using organic material on the land can be retained through safe use. Specific benefits likely in candidate countries include:

- The increasingly contaminated sea water (from the discharges to sea) is causing additional burdens on the desalination plant that provide fresh water to Malta. Reducing contamination will facilitate the desalination process, reducing costs.

1.7.3 Ecosystem Benefits

Ecosystems will benefit from compliance for similar reasons just outlined above in Section 1.7.1. Contamination of land with high heavy metal contents will impact on local wildlife. Run-off into surface and ground waters will negatively impact on ecosystems relying on these environments. Limiting this contamination will therefore benefit ecosystems.

1.7.4 Wider Economic Benefits

The wider economic benefits relate on the one hand to reducing the costs of sewage sludge treatment / disposal. Both may become increasingly important in the context of the Water Directives and adjustment of the likely future development of the Common Agricultural Policy. The associated limits on contamination of surface and ground waters from farming would be costly to address. Compliance would reduce this economic burden by reducing the potential for heavy metal leaching from the soil.

Compliance could also lead to benefits associated with possible farm-income diversification. The proper management and application of sewage sludge will benefit the soil from additional organic matter without the problems associated with heavy metals.

1.8 Batteries and Accumulators

This directive (91/157, amen. 93/86/EEC) seeks to encourage recycling and recovery of batteries and accumulators, as well as placing limits on the marketing of batteries whose mercury content exceeds 0.0005% by weight (or 2% in the case of button cells).

Article 4 also requires plans to ensure that spent batteries and accumulators are collected separately with a view to their recovery or disposal, and Article 7 suggests the use of economic instruments and deposit schemes as appropriate measures. There are also requirements for labelling of batteries and accumulators, as well as requirements to ensure that batteries can be removed from appliances in which they are used (with some exceptions).

1.8.1 Health Benefits

To a considerable degree, these depend upon the way in which batteries and accumulators are currently being treated across the candidate countries. Where batteries are disposed of in landfill sites, there is the risk of contamination of surrounding ground and surface water supplies. These pose a health risk to local populations. Increases in the levels of separate collection and recycling and recovery (and therefore a reduction in the level of landfill disposal), due to the directive, are likely to reduce this health risk

The directive also seeks to reduce the levels of dangerous substances in batteries and accumulators. This will lead to positive health impacts in terms of eventual disposal, and in terms of handling the batteries for recycling and recovery.

Recycling and recovery is likely to reduce the impact from certain aspects of primary production of batteries and accumulators. This may have health benefits for workers and local populations.

Specific benefits likely in candidate countries include:

- In Bulgaria separate collection only exists for industrial sized accumulators, which are mainly exported to Greece for processing. Consumer batteries are landfilled. The directive will be transposed in the regulation on batteries and accumulators containing dangerous substances, which was to be adopted in 1999. It is foreseen that batteries will be partially collected by 2002-2003. Bulgaria needs funds for processing and recycling equipment however. Compliance will limit the amount of batteries that are landfilled with the associated health benefits. To the extent that recycling and recovery increases in the future, there will be health benefits as outlined above.

- In Malta there are no existing treatment facilities for batteries. There is a voluntary scheme for the collection of used batteries. During 1997, 503 retail outlets, 160 schools, and offices and other institutions had been provided with plastic battery bins. However many batteries and accumulators are disposed of at the Maghtab landfill and the rest are stored (7,917 kg in 1997). This has health impacts because of ground water pollution and eventual leachate into the sea, which would be minimised due the directive's limits on battery mercury content.

- In Poland small batteries are usually dumped in landfills and therefore implementation of the directive should have a positively influence on human health.

- There is a very limited collection scheme for batteries so far in Slovakia, which means that batteries currently end up in incineration plants or at landfills hence giving rise to negative impacts on air emissions and toxic releases (especially in illegal landfills). A positive impact on health is expected due to reduced emissions.

1.8.2 Non-health Exploitation Benefits

A reduced risk of contamination from the dangerous substances contained within batteries and accumulators will enhance the quality of soils and water. This will lead to benefits for agriculture as well as fisheries and aquaculture.

Compliance will reduce the risk of land contamination, which might have hampered other land-use activities such as development.

Specific benefits likely in candidate countries include:

- In Malta contamination of terrestrial and marine habitats in the immediate environs of the landfill site can have negative impacts on agriculture, fisheries and aquaculture.

- In the Czech Republic implementation will help to create conditions for establishing effective systems based on the responsibility to return and re-use used galvanic cells and batteries, electric storage batteries, discharge lamps, fluorescent lamps, and accumulators. This will lead to benefits from a reduction in the disposal of these items with the associated risks of contamination of soil and water.

1.8.3 Ecosystem Benefits

Batteries contain a range of dangerous substances that can damage eco-systems. Will the improved collection, treatment and disposal of batteries the risks to eco-systems should be reduced.

1.8.4 Social Benefits

Separate collection systems may lead to an increased awareness of waste management issues amongst the population.

Specific benefits likely in candidate countries include:

- In Malta implementation is expected to benefit firms undertaking private investment in collection and disposal schemes.

- In Turkey implementation will improve public understanding of potential health hazards and different collection and disposal (recycling) methods will develop.

1.8.5 Wider Economic Benefits

Compliance might lead to a positive impact upon balance of payments where metals are currently imported for primary production. Increased recycling and recovery would reduce this economic burden.

Separate collection systems are linked with increases in employment. Increased recycling and recovery with the associated collection schemes would therefore lead to employment benefits.

The directive requires further research and technological developments to minimise the amount of dangerous substances used in the production of batteries and accumulators. Compliance may encourage local industry to develop to meet these demands leading to possible benefits for employment and the wider economy.

1.9 Disposal of PCBs and PCTs

The objective of this directive (76/403/EEC amen. 96/59) is to control the disposal and decontamination of PCBs and equipment containing PCBs, and the disposal of used PCBs in order to eliminate them completely. The term PCBs in the directive is used to denote polychlorinated biphenyls (PCBs) and polychlorinated terphenyls (PCTs). Article 4 of the directive requires Member States to establish an inventory of PCBs and Article 3 requires that Member States take the necessary measures to ensure that used PCBs are disposed of and PCBs and equipment containing PCBs are decontaminated or disposed of as soon as possible. For the equipment and the PCBs contained therein, which are subject to part of the inventory, decontamination and/or disposal is required to be effected at the latest by the end of 2010. Member States are required to draw up plans to this effect. Some aspects of the directive also refer to the accepted methods of disposal.

1.9.1 Health Benefits

PCBs and PCTs are known to be persistent compounds with potentially serious consequences for human health. They have been widely used in dielectrics and transformers in the electricity industry. Their disposal has led to their appearing in seas far from their point of use. Health benefits may be direct and indirect, associated with direct contact and ingestion through consumption of contaminated food (such as fish). Bioaccumulation tends to occur in fatty tissues so organisms at higher trophic levels may be most at risk. The goal of phase-out reflects these concerns.

Specific benefits likely in candidate countries include:

- In Bulgaria there is no inventory of equipment containing PCBs and PCTs. An inventory should be completed in 2001. There is also no legislation in place. It is expected, therefore, that significant health benefits should arise.

- There are few industries that use PCBs and PCTs in Malta. Equipment containing these chemicals is either disposed of at the Maghtab landfill or stored in a warehouse. It is estimated that 8000 litres of PCB oils and PCB-filled electrical transformers were stored at a number of industrial sites. This waste has been awaiting an acceptable management solution for the last few years, which the directive could address. Disposal at Maghtab has health implications because of the leachate that ends up in the sea, with the possible contamination of fish.

- In Poland important benefits will occur as soon as the directive is implemented. The current level of knowledge concerning the dangerous nature of PCBs and PCTs is very low so workers and the public do not take care of the management of these substances. Implementation of the directive should better protect workers health by establishing special procedures on how to manage these substances.

- PCBs and PCTs have not been considered in detail so far in Slovakia. Adoption of the directive there will raise awareness with positive subsequent impacts on human health.

- There are no reliable data on the amounts of PCBs and PCTs in Turkey and therefore, it is not realistic to predict the benefits of reducing these compounds. However, it is clear that lowering their concentrations will provide similar health benefits to the countries where the directive is applicable.

1.9.2 Non-health Exploitation Benefits

Cows milk, dairy products, fish and other products are all susceptible to contamination by PCBs and PCTs. To the extent that consumers consider them a health risk, the removal of these compounds is seen as beneficial.

Specific benefits likely in candidate countries include:

- In Malta the potential contamination of the sea has impacts on fisheries and aquaculture industry. Thus implementation will benefit consumers of these products.

- In the Czech Republic, implementation will help with preparing and compiling inventories of installations and instruments using PCBs and the subsequent completion of a report on the inventory and a plan for the procedure for liquidation of PCBs (so as to comply with the final deadline for destruction by the year 2010). This monitoring will foster proper decontamination and disposal with associated benefits.

- In Slovakia increased awareness will press producers to deal with this problem and remove them from their products. Consumers will benefit from this in the long term.

1.9.3 Ecosystem Benefits

Similar to the above, the health of organisms in the environment will be improved, bioaccumulation effects reduced.

1.9.4 Social Benefits

Benefits may occur from improved knowledge of safety issues. Specific benefits likely in candidate countries include:

- In Malta the coastal area next to the landfill is of high recreational value for locals. Cleaner seas will increase the value of the area as a safe recreational spot.

1.9.5 Wider Economic Benefits

The scale of the benefits is uncertain, however, types of benefits will include, using specific benefits likely in candidate countries as examples:

- In Malta a reduction in the contamination of the sea would enhance the productivity of fish farms.

- In Poland implementation will create a new market for PCBs and PCTs substance utilisation. It is expected that firms that supply the market in PCB alternatives will find benefits.

1.10 Directive on Titanium Dioxide + Daughter Directive

Waste from the titanium dioxide industry is harmful. Consequently, attempts have been made to reduce this with a view to complete elimination. As well as encouraging minimisation, re-use and recycling, the directive (78/176, amen. 82/883, 92/112 EEC etc) requires time-limited authorisations to be granted for the discharge, dumping, storage, tipping and injection of waste (which are otherwise prohibited).

Circumstances for the granting of authorisations (for which, there is a requirement for the provision of specific information) are laid down in the directive. In addition, a competent authority is required to undertake and monitoring and surveillance is required to be in place where these treatments.

Member States are required to put in place a plan for the progressive reduction and eventual elimination of pollution from existing industrial establishments. They are required to provide information showing this (through the authorisations granted). In recognition of this, new establishments are required to obtain prior authorisations that are to be preceded by environmental impact surveys.

1.10.1 Benefits

Exposure to titanium oxide can be harmful to health and the scale of the benefits clearly depends, in part, on the scale of current levels of production, use and the risks associated with alternatives products. Clearly, benefits will relate to the number of titanium dioxide plants. For example, there is only one such plant in Poland.

There will be health benefits to the extent that the levels of titanium oxide industry are reduced because of the associated health risks within the industry. Better control of waste disposal and recycling will also increase the benefits to health where they were causing a risk to local populations prior to compliance. These benefits may be offset slightly by the emphasis on recycling if it increases the exposure of workers to the dangerous wastes.

Social benefits may occur where titanium oxide related plants were causing disamenity to local populations. A reduction in the industry’s activity would therefore give rise to benefits. While the titanium oxide industry is likely to suffer economically, there will be economic benefits to those industries that manufacture replacements.

2.0 QUANTITATIVE ASSESSMENT OF THE BENEFITS OF COMPLIANCE WITH THE WASTE MANAGEMENT RELATED DIRECTIVES

2.1 Introduction and overview

2.1.1 Introduction

This section moves beyond the qualitative assessment of the impacts from the waste management Directives described in the previous section, and aims to arrive at calculated impacts, which are directly comparable across both candidate countries and the directives in question.

This quantitative assessment also deviates from the last section on qualitative assessment in its uniform examination of the impacts across the whole area in question, unlike many of the qualitative impacts highlighted which examined a number of local and regional characteristics. This methodological approach is described in more detail below. It also raises the important point of the need to effectively complement the qualitative with the quantitative assessment to arrive at a holistic picture of the directives' impacts.

The directives to be considered in this section are the Landfill Directive, the Packaging Directive and to some extent the Incineration Directive. A quantitative assessment of these Directives was carried out for the following reasons:

1. The directives in question have specific targets associated with them, which makes analysis manageable. This is in contrast to a number of the other Directives where impacts are likely to vary considerably and would not be predictable in any quantitative manner.
2. The quality and quantity of waste related data, while not perfect (and in some aspects inadequate), is sufficient across the candidate countries to attempt an analysis.
3. Compared with a number of the other waste directives, these Directives are likely to have the largest directly attributable impacts[8].

Aims of the section:

- Derive quantitative measurements for the likely impacts of the directives outlined above in all the candidate countries;
- Ensure that these impacts are directly comparable across Directives and candidate countries;

[8] It is helpful to distinguish between actual impacts and risk of impacts. It is clear that hazardous waste related risks can be very high, but the actual impacts can be zero or very high depending on whether an incident occurs. For "actual impacts or benefits " such as the use of captured methane for energy generation the picture is much clearer and more amenable to analysis. Entering into probability analysis based on risk profiles for infrequent events is particularly complex and typically detracts from the more readily quantifiable results. Hence the choice of directives and impacts to explore. This does not, however, mean that the benefits of other directives are necessarily low; it simply means that as much (if not more) is likely to be gained through qualitative assessment.

- Attempt to value as many important factors as possible while making clear what can be considered relatively insignificant and what cannot be valued at this present time; and
- Outline what further steps could be taken to ameliorate the analysis and provide more realistic quantitative benefits.

While making all efforts to calculate reliable quantitative impacts is important, it is also important to note the inherent weaknesses of such a quantitative assessment. While the directives to be examined set quantitative targets for diversion rates, recycling rates and emission levels, there are still a number of uncertainties associated with, for example how each Member State will act in the light of the directives. These will depend on a large number of factors, many of which will not be clear until nearer the target dates. The quantitative assessment also relies on a number of data sets from a number of sources. As described below the availability and quality of data pertaining to waste management across the candidate countries is not high which brings in further uncertainties. There are also uncertainties associated with monetisation of quantitative impacts (described below). In the light of these uncertainties, this study will arrive at high and low values for the monetised benefits.

2.1.2 Overview of Key Quantitative Results

This short section highlights the key quantitative results, which can be found later in the report, explained in more detail. The findings stem from the quantitative assessment of the impacts from both the Landfill Directive and Packaging Directive.

- The calculated total **avoided methane emissions** (across all candidate countries) under the Landfill Directive range between 639 million and 6,388 million tonnes per year by the year 2020. For individual countries the capture ranges from 94,000 tonnes for Cyprus, to 2,035 million tonnes for Romania.

- Implementation of the Landfill Directive, depending on the path adopted by candidate countries to meet the diversion targets, will lead to increases in recycling, composting and incineration. Under the maximum recycling/composting scenario, the estimated total **increase in recycling/composting** across all candidate countries is calculated to be around 54 million tonnes; and under the maximum incineration scenario, the increase in incineration is calculated to around 71 million tonnes. These scenarios are explained in more details in Section 2.2.2.

- Associated with the increase in the levels of recycling/composting and incineration, implementation of the Landfill Directive will therefore lead to **a decrease in landfill disposal levels**. Estimates for this reduction (per year) by the year 2020 are shown as the levels of disposal under the Landfill Directive, as a percentage of the non-implementation baseline. Under the maximum recycling/composting scenario the disposal would be around 39% of non-implementation levels (i.e. 62% decrease), and under the incineration scenario it would be around 22% of non-implementation levels (i.e. 78% decrease).

- The quantitative assessment of the impacts of the Packaging Directive provide predicated **changes in recycling levels across all materials**. The estimates for the increases in recycling levels for all the candidate countries together, per year, by 2020 are:
  - For paper, around 1.6 million tonnes;
  - For glass, around 1.4 million tonnes;
  - For aluminium, around 39,000 tonnes;
  - For steel, around 350,000 tonnes;
  - For plastic, around 200,000 tonnes; and
  - For wood, around 100,000 tonnes
- For all the recyclables together, the increase will amount to around 3.7 million tonnes.

Section 2.2 focuses on the Landfill Directive and Section 2.3 on the Packaging Directive. Within these the inter-relations between these and other Directives is presented. The specific case of the incineration Directive in the Czech Republic is discussed in Section 3, as the main aim of this analysis has been to highlight an approach to attributing monetary values to this directive. Section 2.4 summarises the purely quantitative analysis.

2.2 Landfill Directive

This first section deals with quantifying the impacts of the Landfill Directive. There are a number of important aspects of the Landfill Directive, which will give rise to significant benefits for the candidate countries. This study splits the quantitative assessment into two parts, each one dealing with a different quantifiable aspect of the directive.

The first deals with the requirement to ***capture methane emissions*** from landfill. This will have an important impact because of the negative affects associated with methane in terms of global warming. The capture will result in either flaring or recovery with subsequent combustion for the generation of energy. The energy generation can replace energy generation from other sources and the associated pollution, again having a measurable benefit. These benefits are quantified in the first section of the assessment.

The second section deals with the impacts from the targets for diversion of biodegradable municipal waste from landfill – reducing the need for landtake, and reducing the risk of environmental burdens associated with the bio-degradable component in landfills. There are a number of uncertainties associated with this because each candidate country can undertake a number of different approaches to meeting these targets. These likely varying approaches however are assumed not to affect the impact from gas capture described above. This assumption derives from a number of considerations including the sizeable historical landfill gas emission and is examined in more detail below.

The main options open to candidate countries, in terms of meeting the Landfill Directive, include incineration and recycling/composting. To capture the possible approaches in the quantitative assessment, this study has examined two different scenarios. The first involves candidate countries meeting these diversion targets purely by a mixture of recycling and composting. The second involves building sufficient incineration plants. In reality the approach taken by the different candidate countries is likely to fall between the two scenarios highlighted, i.e. adopting a mixture of recycling/composting and incineration to meet the diversion targets. Hence by examining these two scenarios, and their associated benefits and costs, this study will arrive at a broad range for the possible benefits and assess which approaches may provide larger benefits. Note that for the candidate countries, it would be foolish to assume that the costs of these options necessarily equate with Member State costs. Although this is more likely to be the case for incineration (because of the high proportion of costs which are related to capital items), the financial costs of recycling, when carried out using labour intense methods (as in many UK schemes), are likely to be quite low (and will provide employment) due to the low labour costs in many of the countries concerned.

For the quantitative assessment of this directive, the study team has therefore been able to address:

- Changes in methane emissions from landfill
- Changes in quantities going to landfill
- Increase in recycling and composting of biodegradable component
- Increase in the incineration of biodegradable component

What the study team has not been able to quantify, includes:

- Level of reduced leachate into land and groundwater;
- Reduction in the risk of explosion or health impacts from gaseous emissions;
- Reduction in the risk of spread of disease due to reduced potential base for disease;
- Reduction in odours and visual disturbance from landfill sites;
- Reduction in noise and disturbance from transport to landfills.

In addition, there is some work ongoing, which is looking into the potential for birth defects to arise in those living near landfills.

The latter points were explored in some detail in the qualitative section, but given the limitation of data availability and the inherent difficulty (scientific uncertainly) in risk assessments and probability analysis, no quantitative analysis was carried out – with the exception of a brief analysis of amenity value (within Section 3 on monetisation) where past studies have overcome some of the problems.

2.2.1 Methane Capture

We have modelled the benefits associated with the capture of methane as required by the Landfill Directive. Before discussing the valuation analysis (presented in Section 3), we first set out our analysis of extent of methane emissions reductions from landfills in the countries concerned.

2.2.1.1 Estimating Methane Emissions

In order to attempt a quantification of the external benefits associated with the Landfill Directive, it is important to have an estimate of the current level of emissions of methane from landfill. It is important for two main reasons. Methane has far greater global warming potential than carbon dioxide and is released in significant enough quantities to be damaging. Collection of methane for combustion converts methane to the less potent greenhouse gas: carbon dioxide. The second reason is that this methane can be collected and used to generate energy, which, in an externality evaluation, will offset environmental impacts associated with energy generation from other sources. Hence it is important to obtain an estimate of total methane generation due to landfill from all the candidate countries.

Methane gas is produced from landfills at varying rates from different materials. In order to understand the quantities of methane produced in landfills in the candidate countries, one would have to understand the nature of the waste landfilled over the past 30 years or so, and to understand the nature of the landfill conditions. Even then, the fact remains that relatively few studies have been carried out on the degree to which methanogenesis occurs for different fractions of the waste stream, and the rate at which it occurs for those streams. It is usually suggested that an exponential decay curve applies to all waste streams and their production of methane, but the completeness of the degradation of carbon through this process in landfill sites varies across materials. Newsprint, for example, may well be a net sequestering of carbon in landfills.

This study requires data for total landfill methane emissions from the candidate countries. It has examined a number of data sources. Estimates of methane generation range to a large degree, and are likely to vary considerably between countries based on variables such as composition and climate. Therefore this study will take a number of different values for methane generation. Two main data source inventories for total landfill methane emissions have been examined in detail in Technical Annex 1, along with a number of statistics for emissions per tonne of MSW landfilled. These estimations vary considerably and hence this study has used data from one inventory (UNFCC) and has estimated a high and low value for emissions per tonne of MSW landfilled. Again this is explained in detail in Technical Annex 1.

For each country, we work with three values for methane emissions:
- UNFCC data;
- Our own low estimate; and
- Our own high estimate.

It is worth noting that for many countries, the UNFCC values do fall within the range of our calculated values.

2.2.1.2 Projections and Baseline

Having estimated the amount of landfill methane emissions per candidate country, the next step in the quantitative assessment involves calculating how much of this methane will be collected and by when.

The amount of methane captured at the landfill is assumed to move from 0% to a specified maximum percentage (60%) of what is emitted in a linear manner over the period to 2009 (the date by which capture has to be in place). We have used a maximum recovery level of 60%, which, upon examination of a number of sources that range considerably, seems sensible. White et al (1995)[9] assume that 40% of landfill gas is typically recovered, although estimated recovery efficiencies of around 90% have been reported (Rodríguez-Iglesias et al, 1999; Huber and Wohnlich, 1999)[10].

The evolution of ‘pre-capture’ emissions of methane over the twenty-year period under examination is not well known, but it will depend upon:

- Past landfilling of waste and its composition;

[9] White, P.R., Franke, M., Hindle, P. (1995) Integrated Solid Waste Management: A Lifecycle Inventory, Blackie Academic & Professional, Chapman & Hall, pp. 362.
[10] Rodríguez-Iglesias, J., Marañón, E., Sastre, H., and Castrillón, L. (1999) 'Characterisation of extraction wells and recovery of biogas in municipal solid waste sanitary landfills', Proceedings Sardinia '99, Seventh International Waste Management and Landfill Symposium, S. Margherita di Pula, Cagliari, Italy; 4-8 October 1999, Volume II, p.457-64. Huber, A., and Wohnlich, S. (1999) 'Gas collection layers' , Proceedings Sardinia '99, Seventh International Waste Management and Landfill Symposium, S. Margherita di Pula, Cagliari, Italy; 4-8 October 1999, Volume II, p.465-70.

- Evolution of waste arisings and its composition;
- Future fates of waste – the Landfill Directive will divert increasing fractions of biodegradable municipal waste (and to a lesser degree, all biodegradable wastes) away from landfill; and
- Landfill conditions.

We suspect that the effect of the Landfill Directive will lead to reductions over time but contributions from past landfill deposits will remain significant. Therefore, given the levels of uncertainty concerning future arisings, and given also that we have used a range of estimates for current emissions, we have assumed constant emissions over the twenty-year period. This is unlikely to be a true reflection of the reality, but the reality is at best dimly perceived at present.

We have simply assumed a baseline of zero methane capture from landfill sites. This is not true for some countries and the situation is changing (partly in response to the directive). We are effectively assuming that all gas capture is related to the directive itself (though other influences, e.g. climate change policy / politics will play a role).

Using these assumptions and the data outlined above, this study calculated the impact of implementation on the levels of methane emissions. The following table contains the estimated reduction in methane emissions per year from all the candidate countries, by 2020. The data is quoted for all three data sets used (UNFCC data, our low estimate, and our high estimate) although it was the highest and lowest results that were used to estimate the range of possible benefits in the monetised assessment.

2.2.1.3 Quantitative Results

Table D1 and Figure D1 present the amount of methane capture - in million of tonnes - under the three scenarios, across the candidate countries. Taking the lower and upper bounds, the benefits for the 13 candidate countries combines, amount to between 0.6m and 6.4 million tonnes of methane. Romania, Poland, and Hungary account for the largest shares of avoided emissions.

Figure D.1 Landfill Directive Methane Capture Requirement: 2020 Changes in Methane Emissions, Low, High and UNFCC estimates

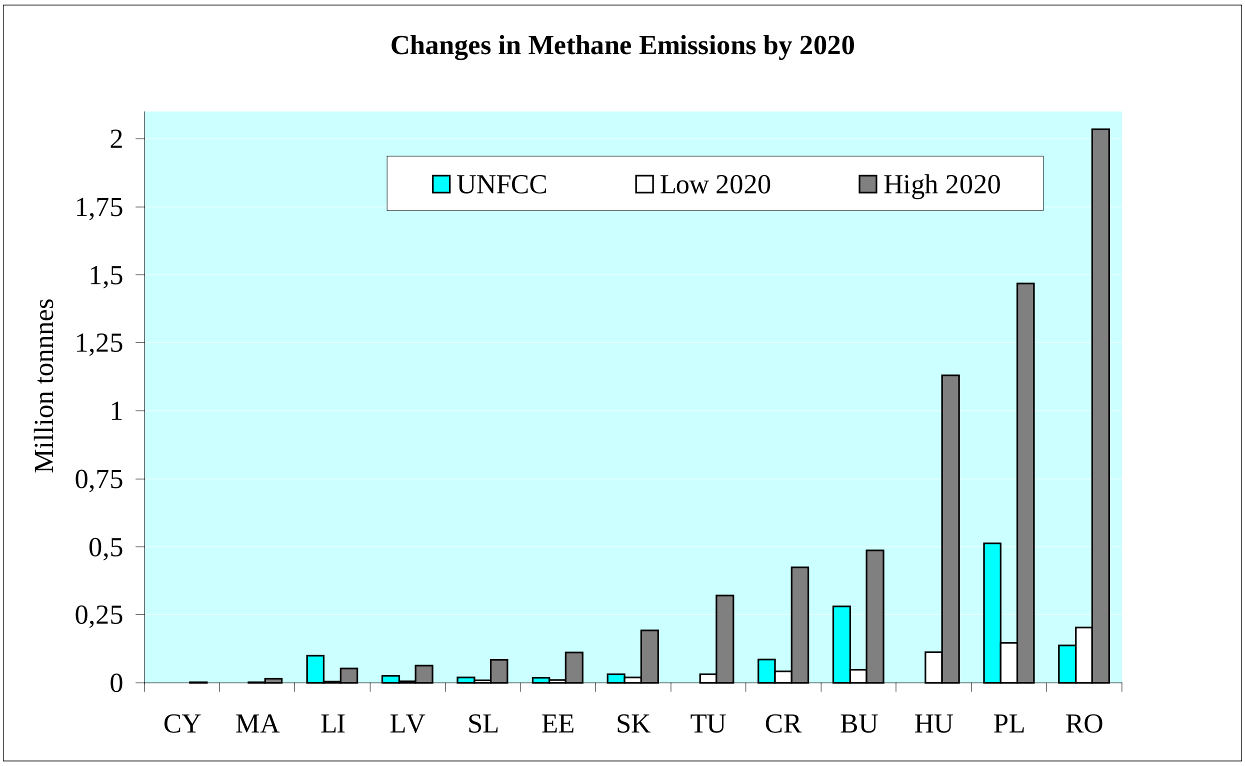


Table D.1: Estimates of reductions in methane emissions per year by 2020 (in tonnes)

	UNFCC	Low Estimate	High Estimate
Bulgaria	281,112	48,740	487,403
Cyprus	ND	94	937
Czech	86,400	42,412	424,124
Estonia	18,600	11,143	111,428
Hungary	ND	113,035	1,130,355
Latvia	26,400	6,268	62,678
Lithuania	99,600	5,271	52,714
Malta	ND	1,578	15,782
Poland	513,000	146,861	1,468,614
Romania	136,800	203,570	2,035,710
Slovakia	31,800	19,359	193,595
Slovenia	19,200	8,411	84,107
Turkey	ND	32,143	321,428
Total	**1,212,912**	**638,884**	**6,388,875**

ND = No Data

2.2.2 Meeting Landfill Directive Article 5 Targets

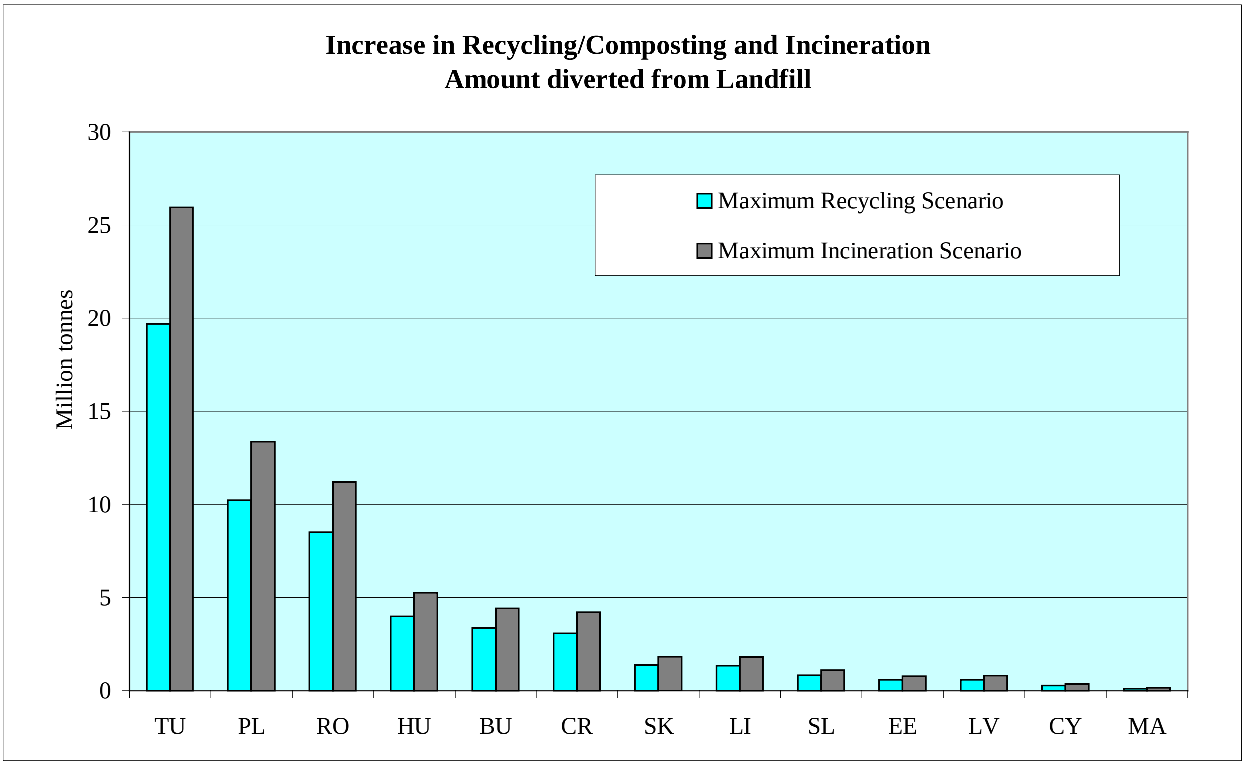
As described above, in meeting Article 5 targets, countries have a choice as to how they meet the requirement to divert waste away from landfill. At two extremes, they could choose either to simply shift waste away from landfill and towards incineration, or to adopt an intensive strategy for recycling and composting. We have effectively chosen two strategies for the way in which countries choose to meet Landfill Directive targets:

- **Maximum Recycling / Composting Scenario**: in which the country concerned pursues an intensive source separation programme generating dry recyclables and compostables.
- **Maximum Incineration Scenario**: in which, the country concerned incinerates the requisite quantity of waste in order to meet the required targets.

It is entirely possible, of course, that countries will adopt a mixed strategy. Our aim has been to bound the range of benefits likely to flow from meeting the directive targets. Having said that, both our review of country data and anecdotal evidence from the qualitative assessment suggest that there is considerable public hostility towards waste treatment plants generally, but especially incinerators.

The quantitative methodology calculates, using data sets for the present waste arisings and treatment processes from each of the candidate countries, how much biodegradable waste would have to be diverted from landfill by each of the target years. Using this information we are then able to estimate how much waste would be diverted into each possible treatment option depending on the scenario in question. The results are summarised in the Figure D.2 below, showing the amount diverted from landfill to recycling/composting (under the maximum recycling scenario) and to incinerators (under the maximum incineration scenario) by 2020.

Figure D.2: Landfill Directive Article 5 Targets: Quantification of Increases in Recycling/Composting and Incineration Levels under the two scenarios



Given the amount of waste, which needs to be diverted from landfill, we can calculate the difference between an extrapolation of the present situation and the impact of the Landfill Directive in terms of increasing various treatment capacities compared with reducing landfill capacity. It is the calculation of this difference, which will give rise to the monetised benefits.

2.2.2.1 Maximum Recycling and Composting Scenario

As mentioned above, in response to Article 5 targets, under this scenario, candidate countries would undertake an intensive recycling and composting programme. There are a number of important factors affecting recycling and composting schemes including the need for participation in separation schemes, and the need for reliable markets for end-products (currently not fully in place, in many of the candidate countries). These factors are complex and require a significant change in population consciousness for the schemes to be effective. Therefore in order to reach diversion targets via recycling and composting, candidate countries would have to implement the necessary schemes over-time, well in advance of the target dates to approach sufficient diversion to meet the Landfill Directive.

Hence we assume that there is a linear increase in the adoption of recycling and composting capacity over time, from present levels in each of the candidate countries. In reality this is unlikely to happen so smoothly but because it will depend on so many different local factors, these deviations would be too complex to model quantitatively.

We assume a maximum MSW recycling rate of 60%, which seems to be a realistic level for separation and recycling schemes (of both dry recyclables and biodegradable waste) to aspire to. Given that the present recycling rates across the candidate countries are relatively low, we assume that this maximum can only be achieved by 2010. This study also assumes that while the Article 5 targets refer to biodegradable waste, the implementation of recycling schemes will apply to both dry recyclables and biodegradable waste. Implementing schemes only involving the source separation of organic waste is generally unlikely because of the associated benefits of recycling, especially once the separation schemes are in place.

This study assumes a constant MSW growth rate over time for both scenarios. While this is unlikely to be the case, there are many uncertainties associated with growth rates. Continued economic growth might be likely to increase this growth while on the other hand, implementing intensive source separation recycling schemes have been found to lead to waste minimisation as people become more aware of what they dispose of. Therefore the benefits of this scenario may be underestimated compared with the maximum incineration scenario.

This model also assumes that there would be a 50:50 split between diversion to recycling and diversion to composting. Again this is likely to vary across candidate countries and cannot be predicted with any certainty.

Because the maximum recycling rate is estimated to be 60%, a country with a high growth rate may well find that it can’t meet its Article 5 targets by recycling alone. This study assumes that any additional diversion requirement is met by incineration (energy-from-waste (EfW) plants).

Table D.3 presents calculated estimates for the combined total of recycled and composted material per year across all the candidate countries by 2020 through implementation of the Landfill Directive and adoption of the maximum recycling and composting scenario by these States. The figures also represent the amount diverted from landfill and hence the reduction in the level of waste to landfill. As it is assumed that candidate countries will adopt equal measures of recycling and composting (as outlined above), approximately half of the values quoted will be composting and half recycling. The only deviation will occur when candidate countries have current non-zero levels of recycling and composting.

Table D3: Maximum recycling and composting scenario: changes in levels of combined recycling and composting across all candidate countries per year, by 2020 (in tonnes)

	Increase in Recycling and Composting
Bulgaria	3,365,289
Cyprus	288,191
Czech	3,084,848
Estonia	590,618
Hungary	3,977,437
Latvia	589,592
Lithuania	1,343,456
Malta	105,130
Poland	10,215,579
Romania	8,502,888
Slovakia	1,379,739
Slovenia	840,329
Turkey	19,687,272
Total	53,970,367

2.2.2.2 Maximum Incineration Scenario

This scenario assumes that the candidate countries opt for the large-scale construction of incinerator plants to meet Article 5 targets. Because incineration does not require the participation of the population, there is no real hypothetical maximum for incineration capacity and it can be brought on-line at any point. On the other hand, public opposition to incineration may be high in many countries across the region, whilst lack of recycling is likely to make the meeting of Packaging Directive targets impossible.

In this scenario, however, we have assumed a step-wise adoption of enough incineration capacity to exactly meet the required diversion at the three Article 5 target dates. Because incineration involves the entire municipal solid waste (MSW) stream, this scenario will involve diversions of higher tonnages from landfill than the maximum recycling scenario, since the average tonne of recycled / composted material is assumed to have a higher biodegradable content than unsorted municipal waste (so less waste needs to be recycled than incinerated to divert the equivalent tonnage of biodegradable material).

We also assume that because any new incineration capacity will be built around the target dates in Article 5, it is likely to be of a relatively high technological level. Therefore we assume that these plants are energy from waste (EfW) plants with associated quantifiable benefits from energy generation.

Table D.4 shows the calculated estimates for the changes in levels of incineration per year, across all the candidate countries by 2020 through implementation of the Landfill Directive and adoption of the maximum incineration scenario by these States.

Table D.4: Maximum incineration scenario: increase in levels of incineration across all candidate countries per year, by 2020 (in tonnes)

	Increase in Incineration
Bulgaria	4,424,219
Cyprus	378,874
Czech	4,197,382
Estonia	776,464
Hungary	5,262,648
Latvia	816,891
Lithuania	1,807,106
Malta	146,313
Poland	13,369,155
Romania	11,207,774
Slovakia	1,819,316
Slovenia	1,106,096
Turkey	25,952,120
Total	71,264,355

2.2.2.3 Changes in Levels of Landfill Disposal

Connected with the increase in recycling/composting and incineration (depending on the scenario examined) there will be an associated reduction in landfill disposal. The following table contains the calculated estimates for this reduction in landfill disposal per year, across all candidate countries by 2020, under both scenarios. It compares a baseline prediction of landfill disposal levels, given growth rates around 2%, to the predicted situation under the Landfill Directive.

Table D.5 shows that the maximum incineration scenario will lead to larger amounts of waste being diverted from landfill. Therefore, in order to meet Landfill Directive diversion targets, principally adopting incineration would require lower landfill capacities than would be required of recycling/composting if these treatment processes were prioritised[11]. In reality, actual reductions in landfill disposal levels are likely to lie between these scenarios, as national waste strategies adopt a mixture of recycling and composting, and incineration. Both the financial costs, and the constraints on access to capital, should favour a strategy based on materials recovery rather than energy recovery.

As shown in Figure D.3 and Table D.5, the level of disposal to landfill is around 38% of the level that it would have been without the implementation of the Landfill Directive and a strategy towards recycling and composting. Where the Landfill Directive is implemented with support of an incineration strategy, the amount of waste sent to landfill in 2020 would be

[11] Waste that can be diverted from landfill to recycling and composting is more specific than the waste that can be incinerated. In other words more waste can be incinerated than recycled/composted. Hence more can be diverted, and less landfill required.

around 22% of the amount that would have been landfilled without the directive's implementation. In the former case, 54 million tonnes will have been diverted from Landfill and in the latter case 71 million tonnes. This would significantly reduce the pressure on existing landfills and reduce the need for new landfill site construction.

Figure D.3: Landfill Directive: Disposal at Landfills in 2020 as a % of Baseline – Benefits of avoided waste disposal at Landfills

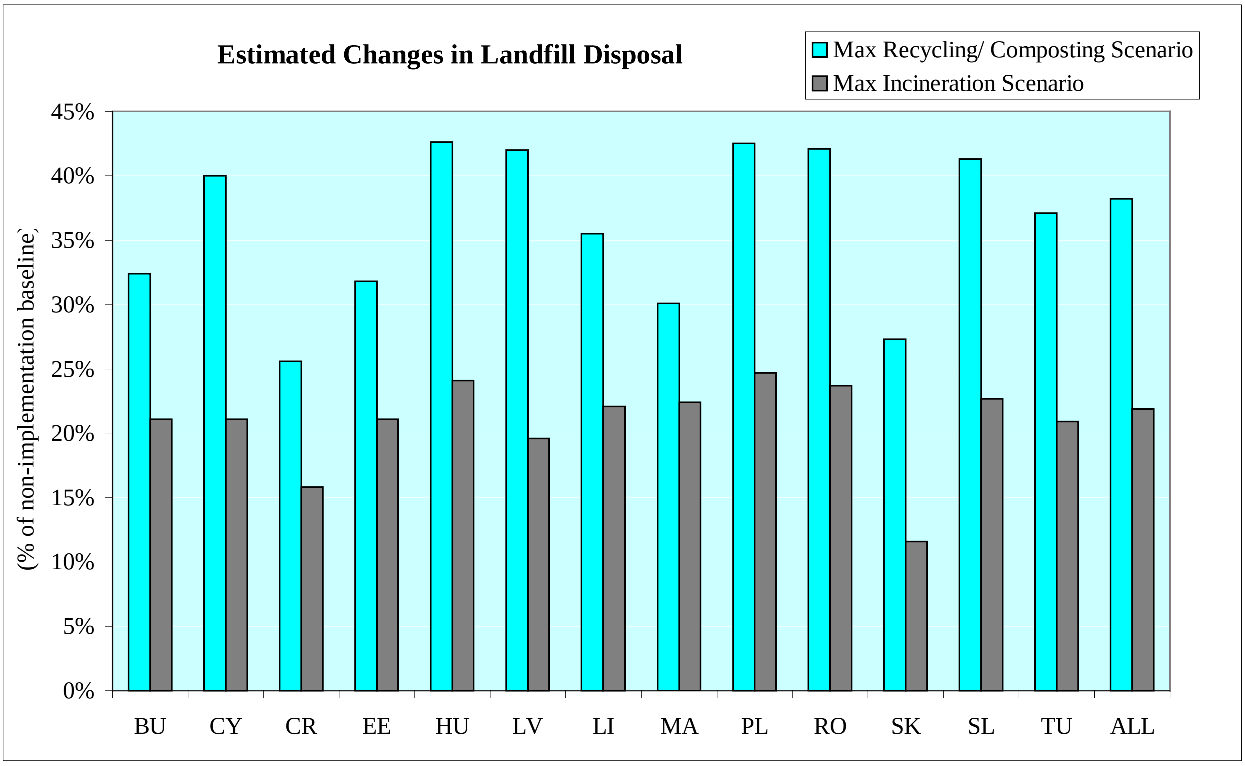


Table D2: Changes in levels of landfill disposal across all candidate countries per year, by 2020, (as a % of the non-implementation baseline) under the maximum recycling and composting scenario and the maximum incineration scenario.

	Max Recycling/ Composting Scenario	Max Incineration Scenario
Bulgaria	32.4%	21.1%
Cyprus	40.0%	21.1%
Czech	25.6%	15.8%
Estonia	31.8%	21.1%
Hungary	42.6%	24.1%
Latvia	42.0%	19.6%
Lithuania	35.5%	22.1%
Malta	30.1%	22.4%
Poland	42.5%	24.7%
Romania	42.1%	23.7%
Slovakia	27.3%	11.6%
Slovenia	41.3%	22.7%
Turkey	37.1%	20.9%
Total	38.2%	21.9%

Note: for the total amounts avoid, recall Tables D.3 and D.4

2.3 Packaging Directive

This section involves the estimation of the benefits from the Packaging Directive. The directive sets recycling targets for a number of materials in the waste stream. To calculate the costs and benefits, this study predicted the impact of the directive in terms of future recycling rates for these materials across the candidate countries, and compared with an extrapolation of the present situation (in terms of current recycling rates).

2.3.1 Recycling Rates

Similar to the Landfill Directive calculations above, this quantitative assessment is complicated by a number of uncertainties. One of the most significant surrounds the uncertainty associated with how each of the candidate countries will meet the targets set by the Packaging Directive. The directive sets minimum recycling quotas for all the materials which will be uniform across the countries in question. However there is also an overall cumulative minimum recycling target for all materials, which candidate countries can meet by encouraging higher recycling rates of certain materials with respect to the others.

As stated above, to derive the costs and benefits from the Packaging Directive, this study estimated percentage recycling rate targets for all materials under the directive. To meet the cumulative target, candidate countries will encourage high recycling rates for those materials with maximum benefits and minimum costs associated with recycling. The scenario for compliance is that for plastics and wood, the recycling rates are at 15% only. This is the minimum required under the directive. All other materials are recycled at a 50% rate with the recovery option making up the slack between the directive's requirement for 50% recovery of all packaging. The 50% rate is achieved by a number of countries in Europe for the materials specified and represents 'over-compliance' in respect of the requirement for recycling. It is, however, a reasonable scenario, and one, which may be closer to what may subsequently be required under a revised Packaging Directive.

2.3.2 Packaging Data

The data we have on packaging is somewhat limited. What we do have does not appear to be perfectly reliable. Unfortunately our research, as well as numerous other examples, illustrates the fact that there is very little waste data available across Europe in general and the situation is even worse in terms of the candidate countries.

Hence in terms of packaging data, we only have data for a handful of countries. However, to carry out an effective evaluation of the impact of the Packaging Directive, it is necessary to obtain estimated packaging data for all of the countries involved in the study. Our approach to filling the gaps in the data where they exist requires making a number of assumptions, which will naturally incur unavoidable errors.

The data required in a minimum scenario includes total packaging arisings for each of the countries involved, as well as a composition breakdown. Each set of data (total packaging arisings and composition) required a separate methodological approach. These approaches and their results are outlined in Technical Annex 3:. To maximise the validity of these assumptions, two methods were used to derive the packaging arisings data for all the candidate countries (again these are explained in more detail in the Technical Annex 3).

2.3.2.1 Baseline and Extrapolation

The rate of packaging waste recycling by material was also scarce. To understand the benefits associated with the directive, one needs to have a baseline from which to proceed. Using the data we had available, we estimated a rate of recycling for each material in the countries for which no data was available. This is clearly arbitrary, though the rates chosen are designed to reflect the inherent ease and economic viability of recycling different materials. Where data was not available, the estimated data was used as the baseline.

We projected forward on a 2% per annum growth (reflecting the supposed linkage between real per capita GDP and per capita packaging waste arisings). We have kept composition constant, though this is bound to change over time.

Table D.6: Packaging waste recycling in three candidate countries

	Lithuania	**Poland**	**Slovenia**	**Estimate**
Paper	24.49%	35.00%	43.00%	20%
Glass	27.27%	6.60%	36.00%	10%
Metals		13.70%	16.00%	10%
Plastics		6.80%	5.00%	5%
Wood			10.00%	10%
Total	*17.89%*	17.40%	29.00%	

This study then combined these estimated for baseline levels of recycling, packaging arisings and composition data with the directive targets for recycling to derive the changes in levels of recycling each year from 1998 to 2020 in all the candidate countries. Table D.7 presents the estimated changes in recycling, brought on by implementation, for all the candidate countries per year by 2020. Figures D.4 and D.5 present the increases in recycling (paper & all recyclables), by 2020 in the candidate countries as a result of the implementation of the Packaging Directive.

Figure D.4: Packaging Directive: Increase in Paper Recycling by 2020

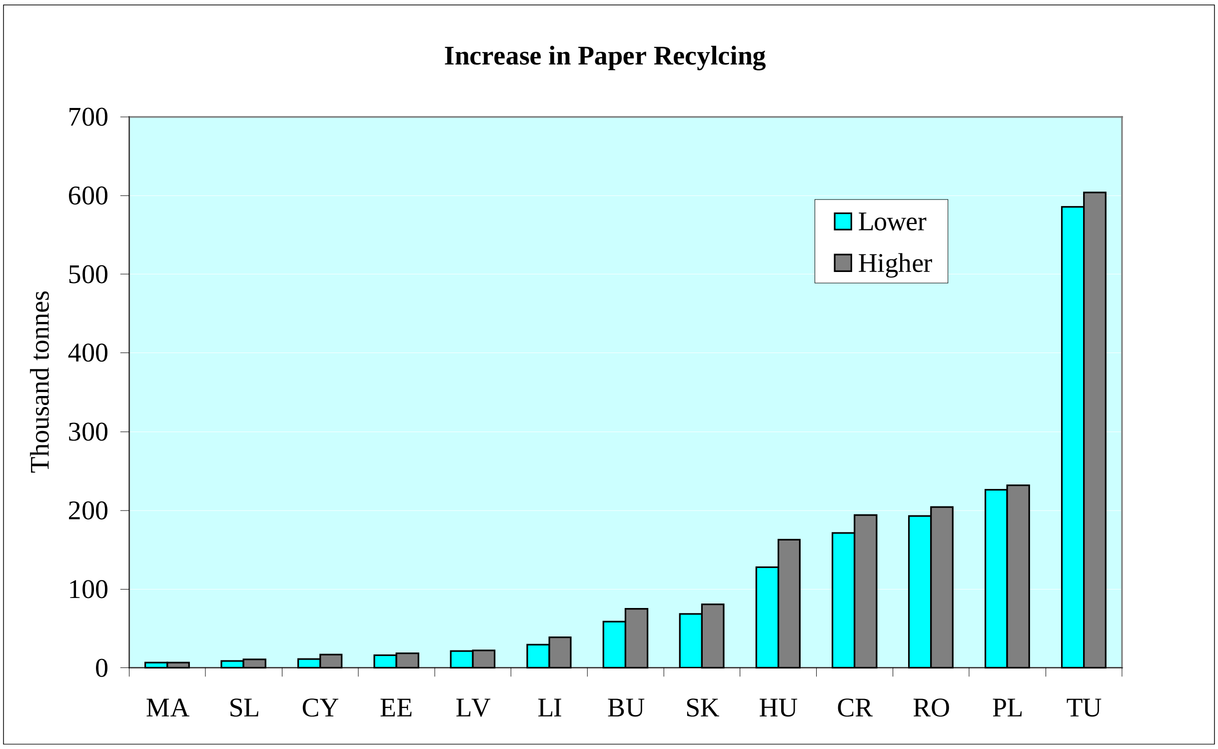


Figure D5: Packaging Directive: Increase in Recycling – All recyclables by 2020

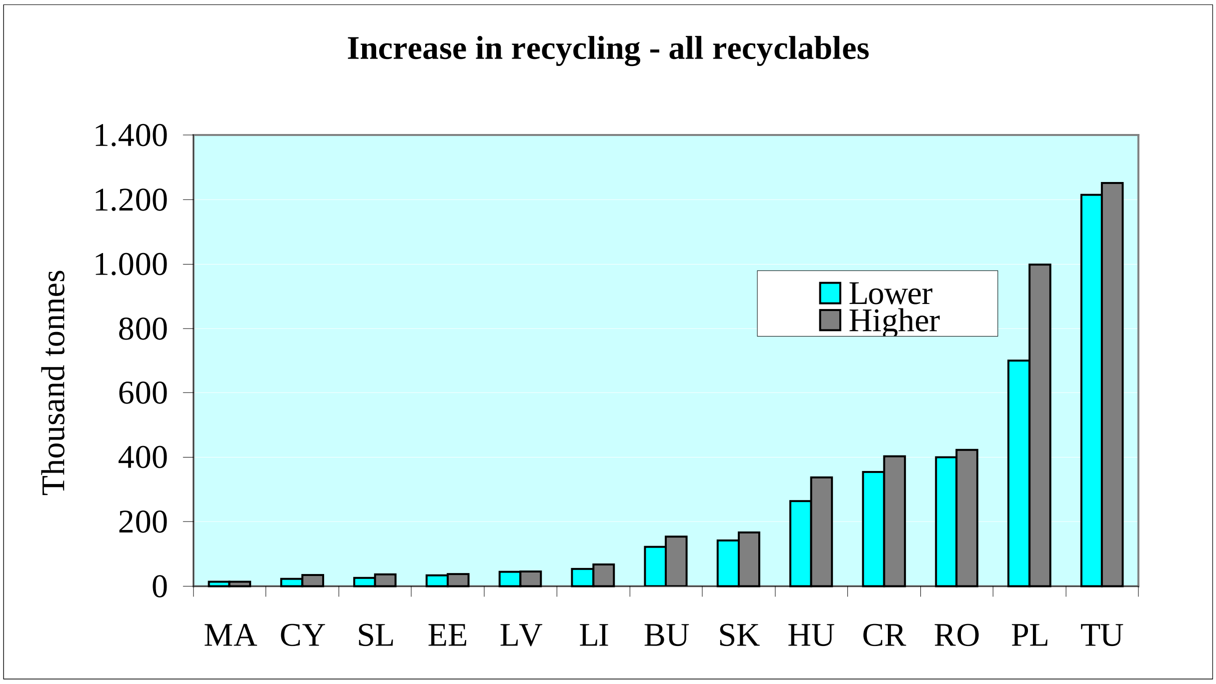


Table D.3: Estimated changes in recycling levels per year, by 2020, due to the Packaging Directive across all candidate countries (in tonnes)

	Paper		Glass		Aluminium		Steel		Plastics		Wood		Total	
	Lower	Higher	Lower	Higher	Lower	Higher	Lower	Higher	Lower	Higher	Lower	Higher	Lower	Higher
Bulgaria	58,727	74,800	40,717	51,862	1,253	1,596	11,276	14,362	6,264	7,979	3,455	4,400	121,692	154,999
Cyprus	11,064	17,078	7,671	11,841	236	364	2,124	3,279	1,180	1,822	651	1,005	22,926	35,389
Czech	171,111	194,489	118,637	134,845	3,650	4,149	32,853	37,342	18,252	20,745	10,065	11,441	354,568	403,011
Estonia	16,001	18,325	11,094	12,705	341	391	3,072	3,518	1,707	1,955	941	1,078	33,156	37,972
Hungary	127,943	162,867	88,707	112,921	2,729	3,474	24,565	31,270	13,647	17,372	7,526	9,580	265,117	337,484
Latvia	21,188	22,155	14,691	15,361	452	473	4,068	4,254	2,260	2,363	1,246	1,303	43,905	45,909
Lithuania	29,320	38,649	13,583	15,460	495	736	4,452	6,620	3,247	3,678	1,983	2,028	53,080	67,171
Malta	6,439	6,840	4,464	4,742	137	146	1,236	1,313	687	730	379	402	13,342	14,173
Poland	226,197	231,897	340,322	603,860	8,758	9,540	78,825	85,862	31,693	39,569	13,527	26,611	699,322	997,339
Romania	192,880	204,588	133,730	141,847	4,115	4,365	37,033	39,281	20,574	21,823	11,346	12,035	399,678	423,939
Slovakia	68,559	80,355	47,534	55,713	1,463	1,714	13,163	15,428	7,313	8,571	4,033	4,727	142,065	166,508
Slovenia	8,606	10,486	5,153	10,905	653	815	5,880	7,334	3,909	4,793	2,146	2,643	26,347	36,976
Turkey	586,033	604,235	406,316	418,936	12,502	12,890	112,518	116,013	62,510	64,452	34,473	35,543	1,214,352	1,252,069
Total	1,524,068	1,666,764	1,232,619	1,590,998	36,784	40,653	331,065	365,876	173,243	195,852	91,771	112,796	3,389,550	3,972,939

3.0 RESULTS MONETISATION

3.1 Introduction

3.1.1 Coverage of Directives

The monetisation analysis has been able to estimate the benefits from the implementation of three Directives:

- Landfill Directive – for all countries
- Packaging Directive – for all countries
- Incineration Directive - for the Czech Republic.

As noted in the introduction to Part D, the analysis has not been able to address the benefits of a number of other waste directives, notably:

- Framework Directive on Waste: 75/442/EEC amended by 91/156/EEC, adapted by 96/350/EC
- Titanium Dioxide + daughters: 78/176, am. 82/883, 92/112 etc.
- Disposal of Waste oils: 75/439, amen. 87/101/EEC
- Disposal of PCBs and PCTs: 76/403/EEC amen 96/59
- Hazardous Waste: 91/689, amen. 94/31/EC
- Sewage Sludge and Soil: 86/278, amen.
- Batteries and Accumulators: 91/157, amen. 93/86/EEC
- Toxic and Dangerous Waste: 78/319/EEC
- Animal Waste: 90/425/EEC, 90/667/EEC
- Control of Transboundary Movements of Haz. Waste and their Disposal (Basle Convention): 93/98/EEC
- Supervision and Control of Shipments of Waste: 94/575/EC, 94/774/EEC, 96/660/EC

This selection does not reflect the importance of the benefits, as clearly many of others - e.g. hazardous waste directive – offer significant benefits. The benefits were described in Chapter 1. The reason for the choice reflects the lack of scientific method allowing for a defensible monetary evaluation for many of the benefits ensuing from the implementation of these directives, and also due to data limitations.

This underlines two points:

a) First that all three tiers of analysis are important in exploring and exposing the benefits, and the monetary evaluation is not the “end point of the analysis”.

b) Second, that the monetary analysis presents a significant under-estimate of the benefits of implementing the waste related directives, and any parties' interested in carrying out a cost benefit analysis of the implementation of the directives in the candidate countries need to bear this in mind, else they will draw the wrong conclusions from such a comparison.

3.1.2 Coverage of Issues in Directives

The monetary analysis has, furthermore, only been able to arrive at defensible estimates for a sub-set of benefits within the directives chosen for assessment. This further underlines the point made above - that the final benefits valuation should be seen as a significant underestimate of the total benefits likely to accrue from the proper implementation of the waste related directives. It is important that the value of benefits obtained from the assessment of the waste directives are not simply compared with the total benefits for the water and air sections to arrive at erroneous conclusions as to the relative benefits of the different media related directives. Furthermore it there should be real caution in any explicit cost benefit comparison for specific directives in light of the fact that only some elements of benefits have been valued. The conclusions drawn from a cost benefit valuation that takes no consideration of these points will in all likelihood be wrong. The coverage of types of benefits stemming from the proper implementation of the directives is presented in the directive specific sections below.

3.1.3 Introduction to methods of valuation

The general approach taken to estimating the value of the benefits of implementing the Waste Directives here makes use of estimated unit damage costs associated with different pollutants emitted to the atmosphere. In other words, we estimate the total reduction in pollutants, and knowing the (range of) value of the benefits from each unit reduced pollutant, the total (range of) benefits is calculated[12].

Most of the studies undertaken to estimate the external costs of waste management options employ this 'externality adder' approach. There are, as ever, some limitations to this approach as the benefits are often location sensitive and hence the externality adders vary significantly across studies. A transfer of unit benefits/costs from one site to another (and one study to another) has to be done with care. For this reason, we have used broad ranges of these adders to lead to a range of benefits estimates.

There are three reasons for doing this. Each raises more fundamental questions about the adequacy of the analysis in the contexts under consideration, yet in the absence of much more detailed (and expensive) modelling, this approach is probably the best available to us:

[12] This is different to the 'bottom up' approach used in the EcoSense model for air emissions (Part B of this report) - EcoSense moves from emissions to impact via dispersion modelling, dose response functions and estimates of the population exposed / stock at risk

1) The first has to do with the presentation of damage costs in this simple way. Using externality adders implies one is transferring estimates from what are often (not always) location specific studies to other places (benefits transfer). It is well known that even if the underlying dose-response functions are known with certainty (and they are frequently not) and are readily transferable (and they might not be), the environmental effects may not be (and this will be implicit in the function) related linearly to emissions. This is especially true where threshold effects are believed to occur;

2) The second is that the impacts are frequently location or context specific. One should not expect the impacts of a tonne of emissions emitted at ground level from cars travelling through the countryside to be the same as the emissions from a 50m high stack in an urban area; and

3) The third addresses limitations implicit in any valuation approach of this nature. There are problems associated with uncertainties in the underlying science (affecting the reliability of dose-response / exposure-response relationships), the ability to model accurate changes in pollutant concentrations and their distribution across media (introducing errors), and methodological approaches to the valuation of mortality and morbidity effects. Different commentators will have subjective views as to the degree to which these have been resolved, yet each imposes a layer of uncertainty on our analysis. Acknowledging these uncertainties and attempting to capture them using these large ranges would seem to be the best approach open to us at this present time.

In essence, therefore, there are limitations to this approach. To move beyond this, however, would require location specific modelling work, perhaps involving comprehensive studies at ‘exemplar sites’ designed to facilitate benefits transfer to other sites suitably classified by type. Even this, however, would not overcome the third of the issues discussed above, that of scientific uncertainty.

Unit Damage Cost Data

We have tried to be reasonably accurate in converting and updating past externality estimates to ensure they are comparable, and are converted accurately into Euros using appropriate deflators and exchange rates. However, the date to which the originals refer is not always absolutely clear. Any inaccuracies will be of limited concern given that:

- Most of them come from relatively recent work so that the impact of exchange rate movements and / or deflators will be relatively small; and
- We are using ranges of values, and the range is typically very large, so that any ‘accuracy’ lost in the conversion and updating is more or less spurious in the context of the ranges available.

With respect to the last point, mindful of the many caveats which need to be applied, we are aiming at illustrating ranges which are plausible on the basis of the existing literature, and with the understanding that the analysis is a long way from being a complete one. It is better, in our view, to indicate a broad range that bounds the potential benefits, as far as they can be discerned, than either pretending that we can undertake valuations in possession of certain knowledge, or adopting a 'lucky dip' approach to the valuation of externalities where one descends upon only one specific study.

We are not well-placed to know what might be the income elasticity of demand for avoiding the external costs being assessed. Coopers and Lybrand and CSERGE (1996) (and Brisson 1997) work on the basis of an income elasticity of demand of 0.3 (using a figure of 1 for sensitivity). A more elastic demand (as has been hypothesised in the context of some agri-environmental studies) would magnify the effects of increased real incomes over the time after the externality assessment was first made. We have simply adjusted unit damage costs on the basis of the purchasing price parity (PPP) ratio relative to the country where the study was undertaken. Exceptions are the unit damage cost estimates, taken from the ExternE programme, for greenhouse gases. The unit damage costs are invariant across countries for these pollutants (which have global effects). Details on the Unit Damage Costs used are given in Annex 1.

The approaches to the valuation work and what we have, and what we have not included, is detailed in the following sections.

3.2 Landfill Directive: Valuation Approach

3.2.1 Introduction

The monetary analysis of the landfill Directive has been able to assess the following benefits (see future below and annexes for details):

- Methane Capture and carbon sequestration in landfills: reduction in global warming
- Methane Capture: energy savings from power generation from captured methane.
- Avoided damage from leachates to ground and surface water and subsequently to human health;
- Reduced disamenity from landfills, given that landfills become sanitary, and fewer landfills needed with the targets inherent in the directive.

A number of benefits could not have monetary values attributed, including:

- Methane capture can reduce the risk of methane leaks, associated explosions, and waste combustion reducing the risk to health
- Improved control of landfills and reduced quantity of landfill can reduce rodents and hence risk of disease
- Reduced volumes of waste going to landfill will lead to less transport and reduced disturbance from waste transport
- Proper disposal of hazardous waste in landfill can reduce risk of future hazards

Given that it has been possible to attribute monetary values to only a sub-set of benefits, the monetary results should be seen as an underestimate and should also be seen in conjunction with the assessments of the type and extent of benefits noted in above sections.

3.2.2 Benefits from Methane Capture

3.2.2.1 Valuation of Avoided Methane Emissions

As methane is a greenhouse gas, the capture of methane leads to a reduced level of global warming, with subsequent benefits of avoided costs of global warming. Methane resides in the atmosphere for a number of years, contributing to warming for a considerable period into the future. Any calculation of benefits therefore depends on the choice of the discount rate; the higher the discount rate, the lower are the damages. For our analysis we have used the core damage valuations from the ExternE work (see
Table D.4)

Table D.4: The Marginal Costs of Methane Emissions

		Unoxidised units (CH4)		
Discount Rate	**Estimate**	**Costs/t CH_4**	**Units**	**€1999**
0%	Low	**504**	**1990$**	526.8
0%	High	**830**	**1990$**	867.5
3%	Low	**300**	**1995€**	326.6
3%	High	**380**	**1995€**	413.7
10%	Low	**24**	**1990$**	25.1
10%	High	**73**	**1990$**	76.3

Source: Adapted from ExternE (1999) Note: different currencies noted reflect original values in the studies

3.2.2.2 Valuation of Benefits Associated with Energy Recovery from Methane Gas Captured

In addition to the impacts associated with avoided methane emissions, we have looked at the energy that might be generated from the gas captured. This study assumes that all of the methane captured is used to generate energy. This is a difficult prediction to make but with increasing pressures from likely future climate change European legislation, countries are likely to make every attempt to limit greenhouse gas generation. This assumption is also balanced by the fact that this study assumes that all the energy generation goes to produce electricity. Combined heat and power generation however would be more efficient and hence would lead to increased benefits.

In the quantitative assessment of electricity generation from methane gas capture, this study assumes a transformation efficiency of 35% and a calorific value of 38 MJ per m^3.

The benefits attributed to this gas capture are critically dependent upon one's assumptions about the source of energy being displaced (for a discussion, see ECOTEC (2000); COWI (2000)). Energy recovered is assumed to displace other forms of energy generation, and the more polluting the source being displaced, the greater the benefits assigned to the energy recovery process. Typically, it is assumed that one is displacing either the marginal (usually most environmentally damaging) source of energy, or the average emissions per unit of energy in the country under consideration. This assumption may not hold where policies are driving forward new sources with low emissions. In any case, it is debatable whether mass burn incinerators can really be treated through marginalist analysis since concerns for the control of the combustion process tend to lead to operation at full capacity as far as possible.

This study has undertaken a review of the available data concerning external costs of these sources. This is reviewed in detail in Technical Annex 1. We will use low and high values of the avoided emissions taken from the ExternE National Implementation Studies (see Table D.A13), adjusted by relative purchasing powers for each candidate country.

3.2.3 Benefits from Meeting the Landfill Directive Article 5 targets on biodegradable waste components

The Landfill Directive requires a staged reduction in the amount of biodegradeable waste that goes to landfill – as a percentage of total waste. The benefits of implementing the directive, related not only to the reduced demand for landfill and associated costs of environmental impacts associated, but also on the nature of the disposal option chosen for the biodegradable component. The disposal options include recycling, composting, and incineration each with different environmental impacts and hence costs. For this study we have chosen two scenario options to represent the range of possible approaches – one a Maximum recycling and composting scenarios, and another a maximum incineration scenario.

3.2.3.1 Valuation Approach

The study analysis compares the possible impact of the Landfill Directive (in terms of two scenarios describing different balances of treatment processes) with an extrapolation of the present situation. Therefore in essence we are comparing different balances of treatment options. In order to carry out this type of analysis one needs to translate data concerning changes in the amount of material sent to different treatment options into benefits assessments. This has been done by deriving unit damage costs for landfill, incineration, recycling and composting. These models are built up from first principles and each is now discussed in turn. In all cases, one ideally models for the dynamic change in waste composition, which occurs as specific materials are recovered through recycling. This is not done here. The assumption is that waste composition being delivered to landfill and incineration is constant (and the composition used is shown in ANNEX 2).

3.2.3.2 Landfill

While neither scenario involves increasing landfill capacity, it is important to derive the unit damage costs associated with landfilling municipal solid waste (MSW). This is because both scenarios will involve displacing waste, which would have otherwise been landfilled, and therefore minimising the problems associated with landfilling waste.

Costs and Benefits of Landfilling Waste

Many of the costs associated with landfill have been examined in the qualitative assessment (including ecosystem, economic and social impacts). Many of these however are specific to local characteristics or are not understood with any great certainty and therefore cannot be modelled quantitatively.

To arrive at a unit damage cost for landfill, we will examine the impacts from carbon dioxide and methane emissions, as well as from sequestration of certain MSW constituents, leachate and disamenity. Much of this is examined in detail in Technical Annex 2 while the following section contains a brief examination of the impacts and assumptions made.

Landfill emissions are approximately half carbon dioxide and half methane. We have ignored the impacts from the carbon dioxide emissions however because they are assumed to derive from biogenic sources. These biogenic sources would have released the same amount of carbon dioxide irrespective of waste treatment process (be it incineration or composting). Therefore in calculating the different impacts from varying waste treatment processes (the basis of this quantitative analysis), because the same amount of carbon dioxide (from biogenic sources) would be released from each, it can be ignored in this analysis.

The methane emissions have been examined however because their formation is due to the comparatively anaerobic conditions in a landfill site. If the material had not been landfilled, and had been disposed of in any other manner, the biodegradation and waste management process would have given rise uniquely to carbon dioxide.

This study has also examined the greenhouse gas sequestration potential of landfill sites. A number of MSW constituents (specifically paper) do not degrade completely under landfill site conditions. Therefore, in comparison with other disposal methods for organic material, the emissions of carbon dioxide from landfill disposal will be lower. Therefore we have used the unit damage costs associated with carbon dioxide, combined with a negative sign, to ascertain the benefits of landfill sequestration.

The impacts from landfill leachate and disamenity are both recognised as being difficult to estimate. For both impacts this study has taken unit damage costs from a recent study for the European Commission (COWI 2000 – see Technical Annex 2). This study adopted the lower and upper bounds of (avoided) damage from (avoided) leachates as 1EUR/t of MSW to 2EUR/t[13] of MSW. For disamenity, a per tonne disamenity externality was used, building on

[13] These were adjusted for purchasing power parities.

the COWI (2000) study, which used the basis of a stylised typical landfill of known capacity. The low and high values are €6 and €19 respectively. These have been adjusted in accordance with the purchasing power of per capita GDP.

Possible Errors and Omissions

Because of the uncertainties associated with the impacts examined briefly above, the resulting estimations of unit damage costs have given rise to large ranges. Notwithstanding this fact, these estimates omit a number of external costs that may well be significant. Hence, these results should not be interpreted as an accurate measurement of the external costs of landfill. Many factors have been omitted. These include:

- Many of the relatively fixed externalities, such as the impacts associated with landfill construction and engineering, any changes in non-use values of specific sites, and perhaps more controversially, any non-market benefits from recreational uses post-closure (these might have to be considered against counterfactual land-uses);
- All impacts associated with the use of on-site vehicles;
- Emissions of gases other than CO_2 and CH_4 (ozone depleting chemicals, such as CFCs, are believed to arise from landfills, whilst as discussed above, dioxins and other pollutants arise in small quantities from the landfill gas engine);[14]
- The incidence, and effects of, landfill gas explosions; and
- A number of other impacts whose status is ‘unproven’ as yet, for example, the possible problems in respect of birth defects that have been mentioned in the context of landfilling (mentioned in the previous Chapter).

All of the above listed factors except one are negative externalities. As such, the net externality is likely to be a more positive reflection of the true situation than is warranted.

This study has also ignored the impact of differing transport patterns associated with both the baseline and compliance scenarios. This is due to the inherent uncertainty associated with impacts from transport and is examined in more detail in Section 6.5 and Technical Annex 2:.

In general, we do not have very good information on a number of key parameters in seeking to model what is going on in landfills. To re-emphasise the difficulties in arriving at a ‘true’ value of the external costs of landfill, we suggest that there will be disagreement about all of the following, each of which determines the external costs of landfilling as we have calculated them:

- Waste composition (varies considerably, each component +/- 50% around the mean, also seasonal);
- Methane generation by components of landfilled waste (relatively few studies have been done here – it is difficult to replicate landfill conditions in a laboratory);

[14] See previous footnote.

Net carbon sequestration associated with components landfilled (the comments in the previous bullet apply); and Oxidation rate of methane at the cap (varies with a number of climatic / meteorological factors).

These difficulties are merely those that exist in carrying out the calculations as we have made them. As regards finding a true value, or even a true range, these difficulties are compounded (and one's efforts are confounded) by the various omissions listed above, as well the uncertainties in placing values upon the emissions such as have been quantified. Quantifying the external costs of landfilling is a far from easy exercise.

3.2.3.3 Incineration

In the same way as was described above for landfill, the following section examines and derives a unit damage cost for incineration, important in estimating the benefits from the Landfill Directive as incineration is one of the diversion processes being considered. As with the case for landfill, and all other waste treatment processes, there are a number of uncertainties associated with both measuring and valuing the costs and benefits from incineration. These, along with the numerous possible sources of data, are discussed in more detail in Technical Annex 2:.

We have tried to model the external costs of incineration of waste in a similar way to the approach taken in the landfill module. In other words, transport is excluded (see below), and we have attempted to model the processes such that the composition of the waste stream is incorporated as far as possible. Again, we have ignored CO_2 deemed to be from biogenic sources. However, we have included those, which are non-biogenic in origin (e.g. from plastics).

In a quantitative analysis of this type, the main costs one is able to value with any certainty are the emissions to air. The combustion process involving such a complex mix of materials gives rise to a number of emissions with possible negative impacts on both the global and local environment. These emissions are again explored in more detail in the incineration section of Technical Annex 2:.

We have taken an approach in which, for the Landfill Directive analysis, we assume all incinerators are compliant with the emissions limits set in the proposed Incineration Directive. For reasons discussed above, this is somewhat controversial. Even plant that appears to comply may not actually be doing so. In our analysis of the Incineration Directive below, we make an estimate of the benefits per typical MSW plant that might accrue if the directive limits are imposed on what one might term a typical plant in the candidate countries.

As regards calorific values for the various fractions of MSW, we use the USEPA (1998) data (Annex 3). With typical compositions of waste, the energy content of a tonne of MSW is within the ranges typically quoted (usually between 9 and 10.5 MJ per tonne of waste). Hence, using the efficiencies of energy recovery used by Entec (1999a), the output energy is suitably close to the values derived in Entec (1999a).

The externalities we have valued are those related to air pollution, recovery of materials from ash, leachate (from landfilled fly ash) and disamenity.

3.2.3.4 Air Pollution

Because we intend to carry out some analysis of the Incineration Directives, we assume (so as to avoid double counting) that the new plant actually complies with the proposed Directive and operates at the limit values proposed. For these, we have again used high and low values for the unit damage costs. Included amongst these are some heavy metals and dioxins, but we have no information on HCl and HF. It is well known that emissions of the former are associated with the presence of PVC (amongst other things) in the waste stream, and that for these reasons, there is some merit in pre-sorting waste to extract this fraction (as happens, for example, in Denmark – see also AEA (2000)). Information on the values used is given in ANNEX 1.

In terms of global impacts, the study values emissions of carbon dioxide from non-biogenic sources, and nitrous oxide. To try and capture the impact of emissions affecting local air quality, we use low and high unit damage costs for the following pollutants: particulates, carbon monoxide, VOCs, arsenic, cadmium, sulphur dioxide, NOx, chromium and a number of other heavy metals. The unit damage costs are examined in the Technical Annex 2:.

3.2.3.5 Leachate

Ash from incinerators arises in two forms. Bottom ash (around 20-25% by weight) and fly ash (around 4%). The latter has to be landfilled, either in hazardous waste landfills or, if the pre-treatment required under the Landfill Directive removes the hazard (through, e.g., stabilisation in cement or through vitrification), at non-hazardous waste landfills. We attribute a leachate externality on the basis of the mass of material landfilled following the approach outlined in the earlier Landfill section, although one would assume that the pre-treatment process and / or the fact that the waste is hazardous would make a higher externality more likely. Fly ash arises through the process of controlling stack emissions of air and dust and contains materials, which are far from inert. The ash is mainly silica or alumina enriched in heavy metals and organic products such as dioxins. The particles also act as condensation nuclei for volatile matter. AEA (1997) cite two studies looking at the problems associated with leachability of chlorine and heavy metals from the two types of ash.

Possibly partly as a reflection of the fact that more is known about the effects of air emissions on health, and more valuation work has been done in this area, the focus of cleaner incineration technologies has been the flue gas. Cleaner technologies may, in part, involve changes in the emissions of pollutants themselves. However, a number of approaches simply result in the removal of pollutants from the flue gas for disposal to other media (land or water depending upon the mechanism). Hence, as long as the emissions relating to discharge to water and land are essentially ignored, the net effect on the ‘bottom line’ figure for the total externality of shifting pollutants from air to land is equivalent to the pollutant having disappeared, even though the net effect has been to shift it from one medium to another (and where it is disposed to landfill, then arguably, from one generation to another also).

3.2.3.6 Bottom Ash Recovery

Only ECOTEC (2000) has attributed benefits from materials recovered in the incineration process. Both steel and aluminium are extracted, now usually post-incineration (from bottom ash). This means that there may be an additional environmental benefit from the recovery of materials (depending upon the net externalities associated with recovering metals through this route). This has been included in the study's quantitative assessment.

We have added an environmental benefit, which is attributed on the basis of an assumption that this material is recycled and that it displaces primary material (see analysis below). This overstates the associated benefit since we have not accounted for the external costs associated with the processes of extracting the materials (magnetic extraction for steel, eddy currents for other metals), and then cleaning them (we effectively assume the materials recovered are used in the same way as metals recovered from kerbside collection). Including these would reduce the estimated benefit associated with the materials recovery (and though one suspects there may still be a net gain here, further analysis would be required to confirm this, especially given the lower quality of the material extracted).

Energy from waste incineration plants are increasingly seeking to make use of their bottom ash, often displacing primary aggregate consumption. This is not happening at all plants at present, but it is becoming increasingly common practice. We credit an additional external benefit associated with displaced aggregates extraction from using this ash.

3.2.3.7 Disamenity

We have followed the COWI (2000) analysis, which, while it accepts there is very little to go on in this respect, suggest a figure of 4 EUR per capita for the EU. This seems low for an incinerator (compared with landfill) given that the population is likely to be more dense.

3.2.3.8 Possible Errors and Omissions

It should be re-stated that this is a far from complete analysis. The following impacts have not been covered:

- All emissions to water;[15]
- Some air emissions for which no externality adders were available;
- Fuel use associated with on-site vehicles and transport of ash residues to landfill;
- Impacts associated with extracting and cleaning recovered materials, and transporting them to reprocessors; and

[15] Kremer et al (1998) list several waste materials, emissions to air not covered by us, and other residues arising from incineration of municipal waste.

- Extraction of primary resources (such as lime used in cleaning flue gas, and water).

One could argue also that leachate and disamenity have not been accounted for adequately.

As with the landfill case, we do not have very good information on a number of key parameters in seeking to model what is going on. Also as in the landfill case, all the unquantified externalities are negative ones. Hence, the net figure is not an accurate reflection of the true situation, which would ideally incorporate the negative externalities mentioned. To re-emphasise the difficulties in arriving at a 'true' value of the external costs of incineration, we expect that there will be disagreement about all of the following, each of which determines the external costs of incineration as we have calculated them:

- Waste composition (varies considerably, each component +/- 50% around the mean, also seasonal);
- An exact computation of the links between waste components and emissions to different media. USEPA (1998) data were used for CO_2 and N_2O emissions. However, in the general case, a number of factors will affect emissions from incinerators (inputs by composition, but also by quantity, depending on how the incinerator has been specified);
- The relevance or otherwise of less frequent exposures to higher emissions of specific pollutants in determining ultimate effects upon which externality calculations are based;
- Efficiency of energy recovery (likely to be known for certain conditions in a specific case, but still exhibiting variation across plants and according to, e.g., completeness of combustion);
- Emissions from displaced energy source such as one believes the assumptions to be correct (depending upon one's assumptions, these may be changing, though for a given assumption, the data ought to be reasonably accurate).

Again as with our landfill, these difficulties are merely those that exist in carrying out the calculations as we have made them. Finding a true value, or even a true range, is made very difficult indeed. Therefore, as in the landfill case, extreme caution is urged in using not just these, but other results that have been generated in this field. Variation can be enormous. The same comments as made in the landfill case regarding any net benefits can be made here.

3.2.4 Recycling

In this part of the work, we take the same approach as we adopted for the work for DETR (ECOTEC 1999; also ECOTEC 2000). The work carried out then was conducted by CSERGE and we have leant on that work in considering the implications of extracting materials from the waste stream. In essence, that work concentrated on the net external costs and benefits of activities involved in recycling relative to the external costs and we adopt the same approach here. The assumptions behind the inventory analysis are laid out in that report.

In our quantitative assessment we have examined the costs and benefits from extracting and recycling paper, glass, plastic (LDPE and HDPE), steel and aluminium from the waste stream. These involve a comparison between primary production and the recycling and use of secondary materials to replace them. By estimating the composition of a typical tonne of materials collected at kerbside, we have calculated the unit damage cost associated with recycling one tonne of waste.

We have left in the model the assumptions in respect of material separation, although an obvious point to be made is that many kerbside schemes have made MRFs (Materials Recovery Facilities) more or less redundant since vehicles with separate compartments can take their place, particularly where plastics are not part of the scheme. We conducted some analysis where we tested the effects of removing the separation energy from the analysis. We found that this had a negligible effect on externalities under both high and low unit damage cost scenarios. The principle reasons why MRFs are omitted in some schemes are financial and logistical ones.

Data underpinning the benefits from recycling are difficult to come by. Most data is old and is country specific. Several countries now make use of software in which such data exists but most seem to rely on a comprehensive programme of research undertaken by the Swiss in 1995. Hence, the data is less than satisfactory and its applicability to the candidate country situation could only be assessed under more detailed study of the specific material-by-material emissions data.

Note that all these approaches assume one is substituting like materials for like. As we pointed out in our earlier work (ECOTEC 1999), this assumption breaks down once market development for secondary materials outlets leads secondary materials of one kind to substitute primary materials of another. However, if one were to extend the analysis to account for this, the analysis becomes increasingly unmanageable.

3.2.4.1 Possible Errors and Omissions

Omissions and limitations in this analysis include:

- The reliance on one set of estimates for the differential impacts of secondary materials reprocessing relative to primary materials processing. The choice of primary and secondary materials plants is obviously important in this respect. Ideally, one chooses (for the analysis we are involved in) the secondary materials reprocessing plants to which materials are sent, and the plants whose output is being, at the margin, displaced. This would involve significant additional work of a country specific nature;
- Whilst in systems in which the secondary material replaces primary material of the same type, the issue of what is displacing what appears to some extent more straightforward than in the energy case, as soon as markets for recycled materials become more diverse, the problem becomes much more complex (since the materials are not being substituted in a like for like process);
- Also, in the same way as we looked at possible variation in the externality adders of incinerators vis a vis displaced energy sources above, similar variation with location

could be expected between primary materials plants and those dealing with secondary materials;

- The omission of all externalities associated with emissions to land and water;
- The omission of disamenity impacts associated with either primary or secondary materials processing and reprocessing infrastructure; and
- The lack of attempts to capture the external costs of primary materials extraction and transport (these are not included in the material-specific emissions data).

An attempt to understand transport impacts of primary materials was made in ECOTEC (2000) but these were specific to the UK on the basis of weighted average distances according to the source of the imported materials. In the same document, an attempt to account explicitly for externalities incurred in primary materials extraction was made for some products.

3.2.5 Composting

Only one study has given a figure for the external costs of composting. This was the work by Coopers and Lybrand et al (1996). However, in our view, this figure should not be used owing to the fact that it included only emissions of CO2 and did not account for the fact that a) this carbon is of biogenic origin and b) that carbon is sequestered in the soil by compost. Furthermore, a number of benefits associated with composting were left unquantified. These include:

- Improved soil structure, porosity and density, improving root environment;
- Increased infiltration and permeability, reducing runoff and erosion;
- Improved water holding capacity, reducing water loss and leaching in sandy soils;
- Supply of macro and micronutrients;
- Control / suppression of soil-borne pathogens;
- Addition of organic matter;
- Cation exchange capacity of soils / growing media improved (so increasing ability to hold nutrients for plant use);
- Supply of beneficial micro-organisms to soils and growing media;
- Improves / stabilises soil pH;
- Potential to bind and degrade some pollutants; and
- Potential to facilitate associations with mycorrhyzal fungi in soil (which are important in facilitating the uptake of micronutrients from the soil.

The UK Environment Agency has done work on composting within its considerable programme of LCA research and the USEPA is in the process of completing a major LCA study, which also looks at these issues. Reports from both programmes suggest that these are the most difficult modules of LCAs to carry out and they are incomplete. We ourselves are now contracted to the Commission (DG Environment) to carry out work on composting and are investigating this data as well as datasets from Sweden, the Netherlands, Austria and Switzerland.

For this study, we propose to use an external cost estimate of EUR 0 per tonne. In our view, the benefits from composting, insofar as they can be captured, are unlikely to be as negative as the Coopers and Lybrand study suggests. Indeed, the total external costs, net of benefits, are likely to be such that there is a net benefit rather than cost.

3.3 Packaging Directive: Valuation Approach

Having estimated these changes in recycling levels for all the candidate countries and for all the materials, we were then able to calculate the benefits and costs associated with the Packaging Directive.

This study derived unit damage costs associated with the production and use of secondary, recycled materials, compared with the primary production of the materials they would replace. This is calculated in the same manner as the unit damage cost associated with recycling described above in the Landfill Directive quantitative assessment (Section 3.2.4).

These unit damage costs were then combined with the calculated differences in tonnages recycled (between baseline and Packaging Directive) for each material in each candidate country to give the benefits of the directive.

As with the Landfill Directive, costs associated with transport differences under the different scenarios was not included in this quantitative assessment. While this is a weakness of the analysis, the justification again is discussed in Technical Annex 2:.

3.3.1 Possible Errors and Omissions

Many of the omissions and limitations associated with the calculation of benefits and costs from the comparison between secondary material use and primary production are similar to those associated with the recycling module contained above within the landfill directive quantitative assessment. These are highlighted above in section 3.2.4.1.

In addition to these limitations, the poor availability of packaging data across the countries involved and hence the need for extrapolation of both packaging composition and arisings for the countries where we have no data, will lead to errors in the benefits calculated for these candidate countries.

In the quantitative assessment of the benefits of increased recycling, the analysis is based on recycled secondary materials replacing primary production and all the associated negative environmental impacts. This requires reliable markets for secondary products. Hence there is an uncertainty associated with being able to replace primary production. The important factors here are complex, will vary according to both location and material and hence cannot be reliably included in a quantitative assessment. As recycling levels increase across the world, markets are likely to become more reliable and better understood which will minimise this uncertainty.

3.4 Incineration Directive: Valuation Approach

Unlike the assessments of both the Landfill and Packaging Directives, this analysis does not calculate the benefits associated with each of the candidate countries because of both a lack of reliable information on the current levels of incineration, and uncertainty associated with future levels. Instead it calculates the benefits per tonne of MSW incinerated, for a characteristic incineration plant and for the Czech Republic as a whole.

3.4.1 The Incineration Directive

The most important aspects of complying with the Incineration Directive are the regulation of emissions to the different media and the maximisation of the recovery of energy. Hence it is important to gain accurate data on waste incineration plants in the candidate countries. We were seeking to obtain following data:

- Amount of waste incinerated (by type of waste).
- Number of incinerator plants (by type of waste).
- Number of incinerators generating energy.
- Current emission levels (relative to Directive limits).
- Potential future predicted level of treatment by incineration (e.g. Landfill Directive incineration scenario).
- Potential energy generation from existing/future plants

There is relatively limited capacity for MSW incineration in the countries concerned though more by way of clinical and special waste incineration. However, the data does not always appear to be very reliable.

We deliberately used Incineration Directive limits in the analysis of the Landfill Directive scenarios, as it seems self-evident that any new capacity requirement will be designed so as to meet these standards. The benefits from the directive therefore arise potentially from two sources:

a) The retrofitting / updating of existing plant (to ensure meeting the emissions standards / energy recovery requirements); and

b) The higher standards associated with any new capacity introduced (though this is somewhat debatable – new plant is likely to have better performance standards than old).

As discussed above, the introduction of incineration capacity for municipal waste is likely to be contingent upon the path followed by countries in meeting Landfill Directive Article 5 targets. As such, the second category of benefits is of less certain character than the first. It is here that we concentrate our efforts below.

3.4.2 Incineration Data Issues

Considering the candidate countries we have found a lot of issues affecting waste incineration strategies. The attitude to waste incineration plants seems to vary across the candidate countries. For example some countries have never used municipal waste incineration plants or only a limited number and they are not going to build new ones in the future (Turkey, Latvia, Poland, Cyprus). On the contrary other countries already rely on municipal waste incineration plants to a significant degree (e.g. Czech Republic, Slovakia).

The calculation of benefits from the Incineration Directive required a comparison of current incinerator emission levels with the limits laid down in the directive. The quality and quantity of information on incinerator emissions across the candidate countries is poor. This study uses the Czech Republic as an example for the purpose of our investigation because of its current reliance on incineration and the availability of data.

For the purposes of this study, we have examined data on waste incineration from the *Waste incinerators in the Czech Republic and their impact upon the environment and public health* (Children of the Earth, Prague, February 10, 2000). This study was supported by the Environmental Partnership for Central Europe, the Open Society Fund, Health Care Without Harm and The Regional Environmental Centre.

This data and our approach to using it in the quantitative assessment are described in Technical Annex 4.

3.4.3 Valuation of the Incineration Directive

Because of the limited data available concerning incineration across the candidate countries, the valuation method in this area is quite limited. However, this is justifiable as large-scale incineration of municipal waste only exists to any significant degree in the Czech Republic and Slovakia, and the plants in each of these respective countries are likely to be quite similar.

The data quoted in Technical Annex 4 was used in this valuation study to estimate benefits from the Incineration Directive. It is assumed that the incinerators that exist in the countries involved in the study will have emission levels similar to the Czech limits highlighted in Table D.A24 (Technical Annex 4). Emission levels are likely to vary considerably but these figures should be reliable as an average while in most cases the incinerators in question lie in the Czech Republic (or Slovakia where the limits will be similar). In many cases the emissions may even be higher than these limits, in which case the benefits calculated will be under-estimates of the potential total benefit of the directive. Energy recovery is another important aspect of the directive and this study calculated the benefits of implementation by comparing the present scenario where none of the three plants recover energy, with the situation in which energy is recovered at 20% efficiency.

Using the difference between both these emission limits (Czech and Directive) and zero and complete recovery, this study calculated the benefit from implementation per tonne of MSW treated (at an EU level in terms of purchasing power parities). In addition, using a 200,000 tonne incinerator as an example, the total benefit was calculated. Finally, using the Czech Republic's municipal waste incinerators, this study calculated the benefits from implementation in terms of those three plants for which emissions data existed.

Table D.A24 (Technical Annex 4:) quotes the Czech limits for emissions to air and how many municipal waste incineration plants meet these limits. It shows that all three of the plants currently meet these limits. This highlights German incineration standards for emissions to air, which are identical to those emission limits outlined in the directive, and which of these same three MSW incinerators meet the limits. It is clear that the plants in question meet most of the limits. However, none of the three meet the limits on NO_x, one does not meet the limit on HCl and two do not meet the limit on dioxins (there is no limit at present in the Czech Republic, nor in other countries – see the qualitative assessment above). Assuming that the actual emissions lie half way between the Czech and Directive limits, the benefits from meeting the directive limits were calculated (excluding benefits from dioxin because of the lack of Czech limit making it impossible to predict an actual emission flow) and combined with the total energy recovery potential for the three plants to give an overall benefit figure. All these benefits are quoted in Table D..

Table D.8 Calculated benefits from the Incineration Directive (Euros/year)

	Minimum	Maximum
Benefits per tonne of MSW treated	14.05	88.97
Benefits from example 200,000 tonne capacity plant	2,810,267	17,793,625
Benefits from Czech Republic (3 MSW Incinerators)	3,398,845	21,520,295

Note: Per tonne benefits and the benefits from the 200,000 tonne plant are calculated using the EU PPP as a base and therefore need to be weighted by the candidate country PPP to arrive at the country-specific value. However, the Czech Republic figure is calculated using Czech PPPs so is country specific.

The maximum and minimum scenarios in the table above refer to the impacts on emission levels described above, combined with low and high unit damage costs associated with each of the pollutants, similar to other areas of this analysis. The low and high unit damage costs reflect the uncertainty associated with the impacts from these pollutants and are described in more detail in Section 3.2.3.3 and in Technical Annex2.

Note that we suspect these estimates understate the benefits associated with air pollution reduction but overstate the benefits from energy recovery (accepting that the PPP adjustment needs to be made). This is because we have effectively assumed that the air pollution related benefits from the directive arise from NOx reduction only, but we have assumed no energy recovery currently in place. We suggest that at existing incinerators, the typical situation may be worse than this where air pollution concerned judging by the comments made in the qualitative assessment above.

3.4.4 Possible Errors and Omissions

Many of the limitations concerning a quantitative assessment of this nature, have been examined above in the incineration section of the Landfill Directive analysis above (Section 3.2.3.8). Some of these issues are laid out again below including other errors specific to this section's analysis. Two issues of common concern for the landfill, packaging and incineration Directive relate to emissions from transport and emissions from construction. The study-team approach is presented in Box D1.

Box D1: Dealing With Transport And Construction Externalities

In the estimation of unit damage costs associated with different waste treatment options–, this study has ignored the relative impact from transport related emissions. The basis of our benefits calculation stems from comparisons between different balances of waste treatment options. These changes usually imply different collection methods and possibly different collection frequencies, therefore involving different transport requirements. However, the exact nature of the changes depends very much on the nature of the collection approach adopted, the vehicles used and the distances travelled both on collection rounds, and in moving materials from the point of collection to their treatment destination. This would introduce a large number of uncertainties into the quantitative assessment. We conclude that the possible errors associated with these uncertainties are larger than any benefits associated with estimating and valuing the relative impacts of the waste treatment options' different transport patterns. These uncertainties are examined in Technical Annex 2:.

Construction Related Externalities

Whilst some studies seek to allocate environmental burdens associated with waste treatment across the whole life-cycle of the facility, our principle focus is on marginal changes in the use of one or other type of facility. We have not made any attempt to attribute environmental burdens associated with, for example, landfill engineering. These burdens, it should be noted, may not be insignificant. They are, however, fixed. The focus of our interest is principally the variable externalities (those that vary with the quantity of waste treated).

As described above, this analysis seeks to quantify and value uniquely emissions to air. While impacts from reduction of these emissions are likely to be the most significant, they ignore the impacts on emissions to other media. These are important because reducing air pollutants in many cases simply involves a transfer of these pollutants to land and water. This transfer may have negative health and ecosystem impacts.

The uncertainty associated with future incineration capacity levels also limits the quantitative assessment by making future benefits very difficult to predict. This is because, as discussed in the Landfill Directive analysis above, candidate countries may take different approaches to meeting these directives, which may involve differing levels of incineration, depending on a large number of local factors.

We assume that future plants would be built to higher technological specifications and therefore would meet the Incineration Directive limits whether it was in place or not. This limits any calculation of benefits to considering existing capacity. To the extent that this assumption does not hold, future benefits from the directive (in the light of other waste directives such as the Landfill Directive which may increase incineration capacity) may be underestimated.

There are also limitations associated with the emissions data used in this analysis. The assumptions concerning emission levels noted above highlight the lack of available data concerning absolute emission flows. This is likely to increase the error.

The calculation of benefits from recovered energy assumes set efficiency levels, which only considers the generation of electricity. Any generation of heat to supply local communities would increase the efficiency and hence the benefits. There are also limitations associated with assumptions concerning the source of displaced energy. This source will vary across the candidate countries and hence the benefits associated with reduced pollution will also vary.

3.5 Benefits from Implementing the Waste Directives: Annual Benefits

The detailed analysis can be summarised by Candidate Country, reflecting the choice of implementation strategy (recycling or incineration led) and the inherent uncertainty in the analysis, as lower and upper bounds. The results are presented in Table D9 below.

The results make clear the nature of the ranges used in this study. The level of uncertainty associated with quantitative assessments of this kind are apparent as, on average, the upper bounds of the calculated benefit are a factor of 10 higher than the lower bounds. Examining the total range of benefits from both the Landfill and Packaging Directives, the higher bounds are around a factor of 20 higher.

The calculations show that the implementation of the two Directives modelled - the Landfill Directive and the Packaging Waste Directive - will give rise to sizeable benefits for all the candidate countries. The total benefits across the 13 candidate countries amounts to between 0.65 billion EUR and 12 billion EUR. The lower bound represents the lower estimate for the Maximum Incineration Scenario (1.3 billion EUR lower bound for the Maximum Recycling scenario), and the upper bound represents the upper estimate from the Maximum Recycling scenario (the upper estimate under the Incineration scenario amounted to 8.7 billion EUR).

Figures D6 and D7 (and Table D9) shows the country split of the monetary benefits. Under the conservative estimate, Poland and Hungary stand to benefit most – by 0.17 billion EUR and 0.12 billion EUR respectively in the year 2020 (benefits accrue over whole period until 2020, but rising to the 2020 levels, given the assumed growth in waste arisings and also given that some targets, notably for the Landfill Directive, fall in the period 2010 to 2020). Under the higher estimate, Poland and Romania benefit most – by around 2.7 billion EUR each.

Figure D.6 Total Annual Monetised Benefits from Compliance: Lower Estimates

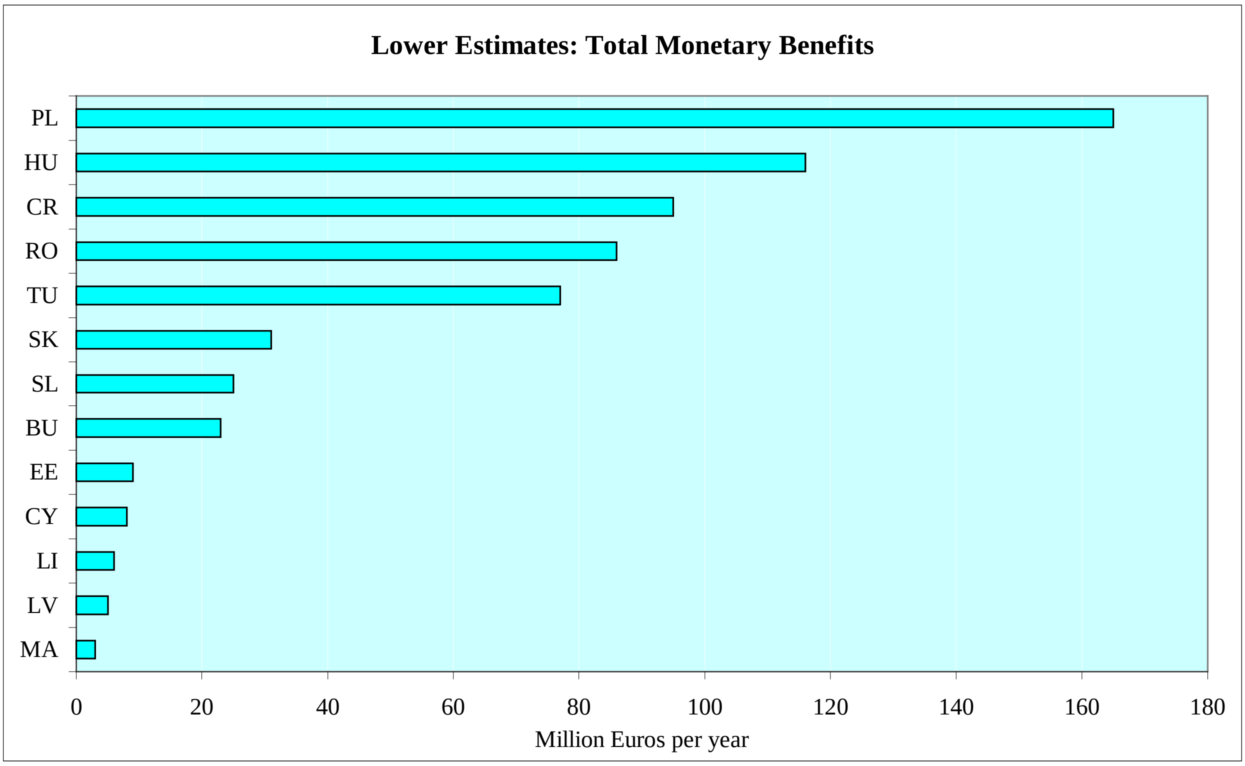


Figure D.7 Total Annual Monetised Benefits from Compliance: Lower Estimates
(Candidate countries presented in the same order as in D7)

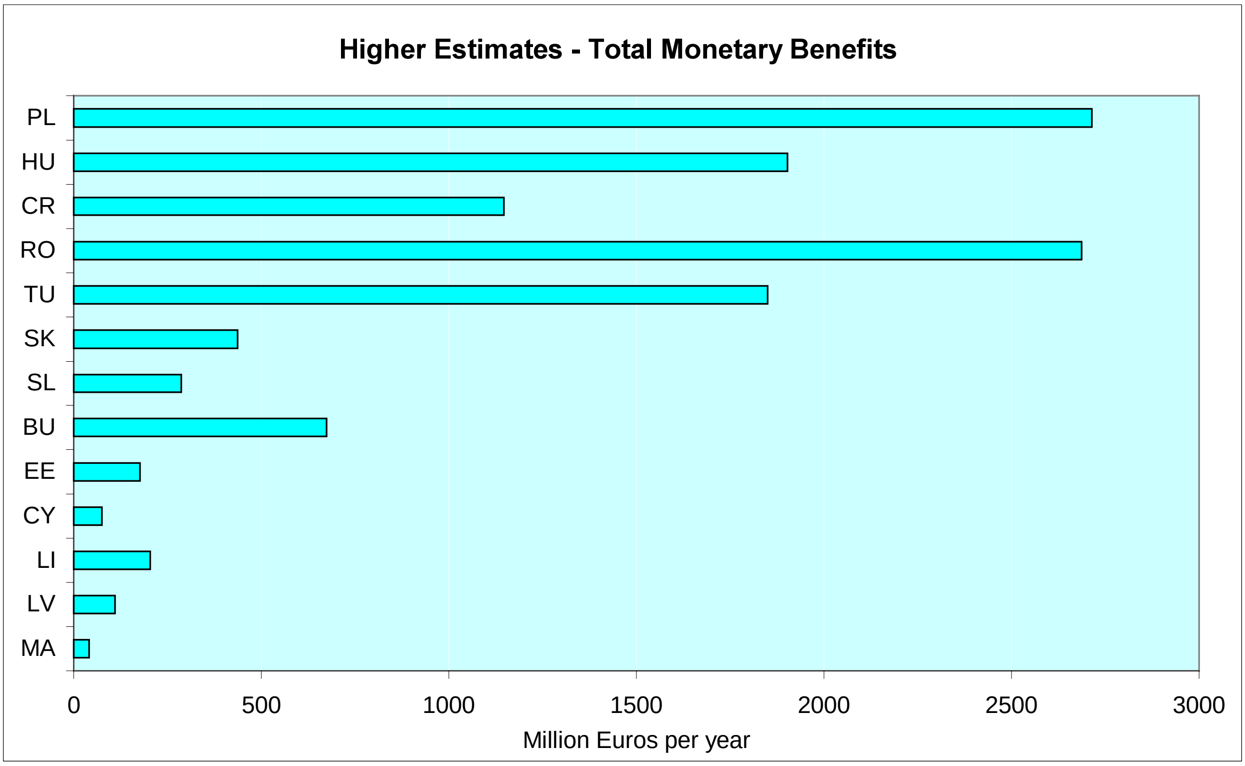


Table D.9: Summary Results of the Estimated Benefits of the Waste Management Directives (Million Euro/Year)

	Landfill Directive				Packaging Directive		Total Annual Benefits from Full Compliance					
	Max Recycling		Max Incineration				Max Recycling		Max Incineration		Total Range	
	Lower	Higher	Lower	Higher	Lower	Higher	Lower	Higher	Lower	Higher	Lower	Higher
Bulgaria	64	642	18	456	4	19	69	674	23	488	23	674
Cyprus	7	49	5	18	2	18	10	74	8	43	8	74
Czech	95	939	60	646	22	148	130	1,147	95	854	95	1,147
Estonia	15	164	7	124	1	7	17	176	9	136	9	176
Hungary	136	1,753	94	1,440	14	107	159	1,903	116	1,590	116	1,903
Latvia	11	98	3	62	1	8	13	109	5	74	5	109
Lithuania	20	185	2	101	2	12	24	204	6	121	6	204
Malta	3	33	2	22	1	5	4	40	3	29	3	40
Poland	231	2,358	105	1,683	35	191	291	2,714	165	2,039	165	2,714
Romania	182	2,584	66	2,071	13	69	201	2,687	86	2,174	86	2,687
Slovakia	36	367	20	253	13	69	48	436	31	322	31	436
Slovenia	24	230	17	151	4	22	33	287	25	208	25	287
Turkey	275	1,519	13	291	42	236	339	1,850	77	622	77	1,850
Total	1,101	10,921	412	7,319	156	910	1,339	12,301	650	8,699	650	12,301

3.6 Benefits from Implementing the Waste Directives: Total Benefits over the implementation period

The benefits noted above are estimates of the benefits for the year 2020. Over the period up to 2020 benefits increase as the directives are increasingly implemented, as the targets stipulated in the directive are met. Furthermore, it is assumed (recall discussion above), that waste arisings would grow at a rate of 2% per year, hence benefits would increase year by year as the additional 2% of waste is appropriately addressed through the implementation of the directives. Table D10, presents the total benefits over the period up to 2020 (in net present value terms).

The total benefits of implementing the Landfill Directive and the Packaging Waste Directive is estimate to amount to between 6.2 billion EUR and 112 billion EUR. As with the annual benefit figures, it would be misleading to present a single central estimate, as this would implicitly suggest a very accurate knowledge of the relationship between pollutant, impact and monetary benefit. Hence, the lower and upper bounds reflect the bounds of confidence in the results given methodological uncertainties. For policy insights (see Part A), it is valuable to look at the implications of the conservative lower bound estimate. Where this has important policy conclusions, it is clear that the policy conclusions would be even more important for the upper estimate.

Table D.10: Total Benefits over the Benefit Period (until 2020), by Media, by Candidate Country *(Net Present value, assuming: 2010 full Implementation Period, 4% Discount Rate) (Million EUR)*

	Low	**High**
Bulgaria	195	6620
Cyprus	75	730
Czech Republic	925	11200
Estonia	95	1750
Hungary	1120	18500
Latvia	50	1070
Lithuania	55	2000
Malta	30	390
Poland	1600	26300
Romania	825	26300
Slovakia	290	4280
Slovenia	240	2820
Turkey	750	18000
Total	**6270**	**112000**

Note: Total may not add to sum of the parts given rounding

3.7 Interpretation of Results

3.7.1 Landfill Directive: Benefits Valuation Results

The difference between the two scenarios, in terms of calculated benefit levels, make clear how important the decision of how countries will meet the directive, is to candidate country decision-makers.

For all of the candidate countries, complying with the Landfill Directive by adopting the maximum recycling scenario should lead to larger benefits than adopting the maximum incineration scenario. In reality, candidate countries are likely to adopt some sort of middle ground between the two extreme scenarios. Results from quantitative assessment indicate that the extent to which decision-makers favour recycling over incineration, should lead to larger benefits.

The extent to which the calculations show the maximum recycling scenario to be giving higher benefits than the maximum incineration scenario varies across the candidate countries. On average the benefits associated with the maximum incineration scenario are just over 50% of the benefits from the maximum recycling scenario.

3.7.2 The Landfill Directive Versus Packaging Directive

For all the countries in the study, the calculations show benefits from the Landfill Directive maximum recycling scenario to be higher than those from the Packaging Directive. For nearly all the candidate countries, the same is correct for the maximum incineration scenario. The only exception to this is Turkey where the lower bound benefit for the Packaging Directive is calculated to be slightly higher than the lower bound benefit from the maximum incineration scenario of the Landfill Directive. This is partly due to the low benefits associated with incineration in Turkey described above.

Because candidate countries are likely to adopt a position somewhere in between the two scenarios, the overall conclusion is that there are higher benefits associated with compliance with the Landfill Directive. The extent to which the benefits are calculated to be greater under the Landfill Directive range from around 20 times the size of the benefits from the Packaging Directive. On average the Packaging Directive benefits are found to be around 30% of the Landfill Directive benefits. Because of the ranges involved however, care must be taken when making these direct comparisons.

3.7.3 Incineration Directive

The results from this quantitative assessment can be found in Table D. (Section 3.4.3). The overall benefit quoted for the Czech Republic ranges between 3 and 22 million Euros/year. This is comparable to the benefits from the Packaging Directive for a number of the smaller candidate countries but is around 13% of the Czech Republic benefits from the Packaging

Directive and 4% of the benefits from the Landfill Directive maximum incineration scenario. It is therefore comparably small even for the country with the highest incineration capacity at present. However, our study only examined existing MSW incineration plants, which will underestimate the overall benefits from the directive.

3.7.4 Significance of Findings

In examining this study's results, it is important to restate the main assumptions made in the quantitative assessment to highlight the significance of the findings and what factors are important in shaping them.

In carrying out such an analysis, which requires a comparison of costs and benefits across countries, there are few impacts which can be valued and monetised as so many depend on local factors. Therefore much of this study's quantitative assessment examined the impact of emissions to air from the waste treatment processes, secondary material recycling, and avoided emissions from primary production and energy generation. This raises the importance of health impacts, which the unit damage costs, are predominantly derived from.

Therefore the results from our quantitative assessment primarily give an insight into the affects on air emissions and hence benefits from reduced negative health impacts from implementation of the directives. Hence if we accept this methodology and connected results, we can see that the Landfill Directive is more beneficial than the Packaging Directive across all candidate countries in terms of reducing air emissions and minimising negative health impacts. Therefore the obvious conclusion is that, in terms of quantitative assessments of this nature, directives, which have the largest impact on reducing air emissions, will have the largest benefits.

The results from this quantitative assessment are informative and have attempted to focus on the significant impacts of the directives in question, while providing ranges to maximise accuracy. It has limitations however, as does any quantitative assessment. These are described in the next section along with possible future steps to arrive at a more holistic analysis and more accurate results.

4.0 SUMMARY AND INTERPRETATION OF RESULTS

This section outlines a summary of the assessments carried out in this study along with gaps, which could be addressed in the future.

4.1 Summary Results of the Assessment

The EU Waste Directives will lead to major changes in handling, treatment and disposal of waste in the candidate countries. The candidate countries have a wide range of ways in which they can choose to implement the set of waste directives. For example, they can choose to give priority to recycling or to incineration. This choice will affect the extent and value of the benefits arising from each Directive. It is therefore not always possible to identify exactly what will occur as a consequence of a specific Directive.

The main benefits from implementing the Waste Directives are:

- Lower pollution to groundwater and surface water from leakage of unprotected landfills and, as a result, lower risks of contaminating drinking water.
- Reduced health and explosions risks as well as lower impact on global warming as methane emissions from landfills are captured and made to generate energy. Existing landfill sites will have to be upgraded and illegal dumping sites closed.
- Benefits to eco-systems and other environmental resources as emissions from waste activities into air, water and soil are reduced and the recovery of energy is increased through the Incineration Directive.
- Increased efficiency in the use of material and reduced production of primary material as a result of higher levels of recycling. This is a result of the targets of the Packaging Directive as well as diversion targets from the Landfill Directive.
- Lower costs for waste collection, treatment and disposal, as less waste will be produced.
- Better management and monitoring of waste streams through the Waste Framework Directive.

EU waste directives will help avoid:

- Pollution into air, soil and water (methane, CO2, particulate, heavy metals from sewage sludge, PCBs/PCTs, waste oil) and ecological risks from waste treatment sites and hazardous waste.
- Respiratory diseases and noise nuisance to local population, risks to health from contaminated water supplies, air and soil.

Extent of the benefits

- The full implementation of the Landfill Directive will lead to a reduction of methane emissions (captured) of between 0,6 and 6,4 million tonnes annually by the year 2020.[16]
- In spite of a 2% growth in waste generation, the Landfill Directive is estimated to reduce the waste disposed in landfills from some 59 million tonnes in 1998, to around 35 million tonnes by 2020 if the candidate countries grant priority to recycling and around 20 million tonnes if incineration is chosen as the preferred option.
- In light of the Packaging Directive, recycling levels will, by the year 2020, have increased by 1,6 million tonnes for paper, around 39.000 tonnes for aluminium, and for all the recyclables together, around 3,7 million tonnes.

Value of the benefits

The value of the benefits from EU waste directives (Directives on Landfill and Packaging Waste) has been estimated for all candidate countries. This is based on two scenarios, one with a maximum level of recycling and the other with a maximum level of incineration, giving benefits with a lower and a higher bound for each scenario.

The total annual benefits from full compliance with the Landfill and Packaging Directives were estimated to be higher under the scenario with a maximum level of recycling. In this case, they range from 1,3 to 12,3 billion € a year. Under the scenario with maximum incineration, the benefits stand at some 0,6 to 8,7 billion € a year. Across all scenarios, benefits from EU waste directives range at 0,6 to 12,3 billion € a year. The implementation of the Landfill Directive contributes with the largest share of these benefits.

Landfill Directive: For all of the candidate countries, complying with the Landfill Directive by adopting a maximum level of recycling should lead to larger benefits than maximising incineration. Benefits for all countries amount to between 1,1 and 10,9 billion € a year for the recycling scenario against 0,4 to 7,3 billion € a year for incineration. In reality, the candidate countries are likely to adopt some sort of middle ground between the two extreme scenarios of maximum recycling and maximum incineration. At country level, the highest annual benefits accrue to Hungary (0,15 to 1,7 billion €), Poland (0,25 to 2,5 billion €) and Romania (0,2 to 2,6 billion €).

Packaging Directive: Total benefits from the Packaging Directive range from 156 to 910 million € a year for all candidate countries taken together. This relates to the benefits from avoided environmental damage by using secondary materials (e.g. recycled paper, aluminium and glass) instead of more primary materials. The largest annual benefits are experienced by Hungary (10-107 million €), Poland (35-191 Million €) and the Czech Republic (22-148 million €).

[16] As noted above, the landfill directive provides for gradual implementation (with staged targets) with all provisions needed to be carried out by 2020. This is why this section uses 2020 rather than 2010.

Incineration Directive (Czech Republic only): Incineration gives lower benefits. This is clearly illustrated by the example of the Czech Republic for which benefits from complying with the EU incineration directives ranges from 3 to 22 million € a year. This is only around 13% of the Czech Republic's benefits from the Packaging Directive.

It is important to underline that the final benefit value related to a small sub-set of the waste related directives and therefore underestimate the total benefit of implementing the waste related directives. It is therefore important to see the final monetary values in this context and to avoid simplistic comparisons with the estimates of the benefits accruing from the implementation of directives in the air and water sectors, or indeed a comparison with cost estimates. Any such comparison would need to be done with full information of the other benefits not monetised and in light of the assumptions. It is therefore particularly valuable to see the monetary result as an indicator of importance of implementing the waste related directives, seen in the context of the broader qualitative analysis.

4.2 Summary of Analysis Approach

The qualitative assessment examined the following waste directives: Framework Directive on Waste, Landfill Directive, Packaging Directive, Incineration Directives, Hazardous Waste Directive, Disposal of Waste Oil Directive, Sewage Sludge and Soil Directive, Batteries and Accumulators Directive, Disposal of PCBs and PCTs Directive, and the Titanium Oxide and Daughters Directive. The extent of the analysis of each one depended on both the likely scale of the benefits to the candidate countries, and the availability of the information required. Each analysis examined the health, non-health exploitation, ecosystem, social and wider economic benefits of compliance.

The quantitative assessment on the other hand only examined the potential benefits from the Landfill Directive, Packaging Directive and Incineration Directive. As described in the methodological discussion, the externalities that we were able to value were principally associated with health impacts. There are obvious gaps in the scope of both the methodology (these are explained and justified in the methodological discussion and the potential for future work is examined in Section 4.3) and the directives examined.

The qualitative assessment outlines important possible benefits from the directives not analysed in the quantitative assessment. For example, the potential benefits for health from compliance with the Hazardous Waste Directive are significant. Therefore it would be possible to apply this study's methodology, which has yielded interesting results, to the assessment of other Directives such as this one. An examination of the extent and type of qualitative benefits (especially related to health for this methodology) from the directives not examined in the quantitative section gives a good indication of the scope for expanding the analysis. Examples include quantitative assessment of the benefits from the Hazardous Waste Directive (as mentioned above), the Sewage Sludge and Soil Directive and the expansion of the Incineration Directive analysis as described in Section 4.3.

The results from this study do allow some important comparisons to be made. The advantage of attempting a holistic assessment of the benefits is that one is able to examine the combined results from the qualitative and quantitative assessments. While these results are not directly comparable, they are informative in a number of other ways.

The quantitative assessment found there to be significant benefits from compliance with all the directives examined, as outlined above in Section 3.0. As described above, this analysis was primarily based on the health impacts from changes in the levels of various emissions to air. The potential benefits to health were also examined in the qualitative assessment and were found to be numerous. These potential benefits went beyond only examining air emissions and included a number of other factors. The qualitative assessment also went beyond simply examining the health benefits and examined a number of other spheres. This qualitative assessment found the scope of these other benefits also to be significant. Therefore even though the quantitative assessment examined a relatively narrow range of possible benefits, compared with the qualitative assessment, the calculated benefits were still significant. Therefore if it were possible to value all these other potential benefits examined by the qualitative assessment, the resulting potential benefit to the candidate countries from compliance would be considerable.

While the qualitative assessment is important in looking at the scope of possible benefits to candidate countries from compliance (and these benefits were found to be significant), it offers no possibility of comparing the relative importance of these benefits for example between directives. The quantitative assessment becomes important in making these direct comparisons, for example comparing the possible levels of benefit from the Landfill Directive, with the Packaging Directive. This study found there to be larger potential monetised benefits from compliance with the Landfill Directive. The analysis was mainly restricted however to valuing the impact of air emissions on health. Therefore in synergy, these assessments prove useful as mutual reference points.

The qualitative analysis raised the issue of certain candidate countries voicing a concern about the possible adoption of incineration in the future. It was difficult to ascertain how widely this feeling was held across the countries examined. This concern seems to be reinforced by the quantitative assessment of the benefits from compliance with the Landfill Directive. The results show the benefits from the maximum recycling scenario to be substantially higher than the maximum incineration scenario. Therefore the assessments seem to agree on the risk to health from incineration compared with recycling.

The qualitative and quantitative assessments also agreed on the importance of health benefits (because the quantitative assessment was principally based on health impacts from compliance). Both assessments found these benefits to be potentially significant. The quantitative assessment found the benefits from the Landfill Directive to be more significant than those from the Packaging Directive. This adds value to the qualitative assessment because although it finds compliance with the Landfill Directive to bring a wider range of benefits than compliance with the Packaging Directive (as well as benefits from replacing primary production, there are additional health benefits from the capture of methane and the generation of energy), the nature of the qualitative assessment makes it impossible to make these direct comparisons.

One of the most important conclusions therefore, from this aspect of the study, is the substantial potential benefits to candidate countries from compliance with the waste directives examined. This is clear if the significant levels of benefits calculated by the quantitative assessment, are extended to the wider scope of benefits (in terms of spheres and directives examined) outlined by the qualitative assessment. Further work could therefore build on this study to examine a number of the gaps outlined above where significant benefits are expected from compliance.

4.3 Quantitative assessment limitations and possible future steps

Many of the possible omissions and errors specific to the quantitative assessments of each of the directives examined in this study have been outlined in the relevant sections above. This section examines some of the generic weaknesses of a quantitative assessment of this nature and how one might seek to address these by conducting further work in the future.

4.3.1 Country Specific Scenarios and Assessments

The quantitative assessment carried out in this study, along with a number of others of this nature, calculates the benefits by comparing an extrapolation of the present situation with a future scenario in compliance with the directives in question. This assumes that the candidate countries would not have put in place any of the actions considered to meet the directives, in the absence of their implementation. The study has shown however that there are substantial benefits associated with implementing these changes. Therefore it is possible that in the absence of implementation, candidate countries would still implement a number of these waste management changes such as capturing methane from landfill sites and encouraging recycling. This would make the benefits calculated in this study larger than they might otherwise be. A more detailed analysis of each candidate country in terms of local conditions and future plans, combined with a more detailed country specific quantitative assessment, would address these possible inaccuracies.

This country specific analysis would also address uncertainties associated with candidate countries adopting varying strategies to comply with the directives. This study tackles this by examining two extreme scenarios to capture maximum and minimum benefits from compliance. The wide ranges produced introduce uncertainties as they make it difficult to arrive at precise benefits. This would be addressed by examining each country more closely, deriving a likely scenario for each one and carrying out country specific quantitative assessments.

In the quantitative assessment, we have assumed that all the candidate countries will meet the targets imposed by the directives in question, by the years specified. This assumption introduces uncertainties associated with possible failures to comply. This would reduce the calculated benefits for the years specified and with a non-zero discount rate, would reduce them further in relation to the present time. A more detailed examination of both the present situation in the candidate countries, and the rate of adoption of recycling in other areas of the world, might help build future scenarios that would address this uncertainty.

4.3.2 Broader Analysis

To assess the benefits of compliance, we derived and valued relative costs and benefits associated with different treatment processes. However we believe the externalities associated with the composting process to be particularly inadequate. We assumed a zero unit damage cost associated with the process but believe that a more thorough examination of the process, including valuing secondary materials replacing primary production (e.g. fertilisers), would reveal positive benefits associated with composting waste. Inclusion of this in the quantitative assessment would lead to larger benefits associated with the Landfill Directive's maximum recycling scenario. Further work in this area could also include examining the process of anaerobic digestion as an alternative to composting in the treatment of biowaste, also with associated benefits, in this case replacing primary production of both fertilisers and energy.

The analysis also did not consider both transport and construction related externalities. Further examination of the different waste treatment processes and collection methods could lead to a more holistic evaluation.

4.3.3 Refining Externalities

As recognised above, varying the composition of waste will impact on the externalities associated with different waste treatment processes. Increased recycling, as a method of complying with both the Landfill and Packaging Directives will alter quite considerably the composition of waste that is both landfilled and possibly incinerated. Further work, involving an analysis of both existing and future waste composition across the candidate countries, as well as the impacts of varying the ratios of waste treatment processes, would enable us to achieve a more accurate picture of the impacts from different methods of compliance.

The large ranges of possible costs and benefits, modelled in our study, indicate the level of uncertainty at present associated with the impact of certain micro pollutants such as dioxins and fine particulates. The ranges, by their very nature, seek to address this uncertainty but future research may provide a more accurate insight into potential health impacts and therefore allow a more accurate analysis.

4.3.4 Further Examination of the directives

While this analysis has attempted to minimise the overlap between benefits from compliance with the directives in question, this proved unavoidable in certain cases. For example the Landfill Directive's maximum recycling scenario considers the benefits from recycling paper from the MSW stream. However packaging waste will include some of this paper, and therefore meeting targets imposed by the Packaging Directive will overlap with recycling to meet the Landfill Directive. From the point of view of the candidate countries, this makes encouraging recycling beneficial as it would help meet both the Landfill and Packaging Directive targets. However, combining the calculated benefits would involve a certain amount of double counting. Although it is likely to have a comparatively small impact on the results because of the large ranges involved, further work would identify this double counting and eliminate it to provide a more accurate picture of the joint benefits.

The calculation of benefits from the Incineration Directive was limited in this study to only one of the candidate countries. Better information on current incineration capacities across all the candidate countries would enable a more complete analysis, similar to that carried out for the other directives. The assessment could be further improved by an examination of the possible emission levels from proposed future plants. This would validate or refute our assumption that future plants across the candidate countries would meet the directive limits and therefore, only the impact of retrofitting existing plants needs to be considered. If the assumption was refuted, it could be followed by a more accurate quantitative assessment.

ANNEXES

ANNEX 1:

EXTERNALITY ADDERS USED IN THE ANALYSIS

There are a number of studies that have looked at the external costs associated with different air pollutants in particular. We have not made a completely thorough investigation of these. Below, we list studies we have looked at and the values for the unit damage costs, or externality adders, that have been derived. For some key pollutants, we show some of the studies consulted. For others, we simply present the ranges used and the sources consulted.

Particulate Matter (PM_{10})

We have looked at UK and European studies. For comparison, RPA and Metroeconomica site US-based studies by Rowe et al (1995) and Thayer et al (1994) which give values of 20,534 ECU per tonne and 46825 ECU per tonne), respectively.

Note that some estimates are for all particulates or Total Suspended Particulate matter (TSP), whilst some are for PM_{10} specifically. We have used low and high values of EUR 8,000 per tonne and EUR 70,000 per tonne respectively. We accept that not all these studies are strictly comparable – they tackle pollutants arising in different contexts. The variation is therefore very significant. Clearly, one could seek to adjust values for rural and urban areas, especially in respect of transport if the ECMT (1998) study is to be believed.

Sulphur Dioxide

See **Table D.A2** for studies reviewed. Note not all studies include all effects. We have used a low value of EUR 3,500 per tonne and high value of EUR 22,000.

Oxides of Nitrogen (NO_x)

See **Table D.A3** for studies reviewed. The values used in this study are, at the low end, EUR 6,500 and at the high end, EUR 40,000.

Table D.A1: Estimates of Damages from Recent European Studies

Study	Study Area	Pollutant	Damage		
			Low	**Central**	**High**
Krewitt *et al* (1997) (ECU per tonne)	UK/Germany[1]	Particulates	22046		60439
CSERGE (1993) (ECU per tonne)	UK	Particulates		12240	
AEA (1997) (ECU per tonne)	Birmingham, UK (50m incinerator stack)	PM_{10}			
AEA (1997) (ECU per tonne)	Birmingham, UK (90m incinerator stack)	PM_{10}			
AEA (1997) (ECU per tonne)	Birmingham, UK (100m incinerator stack)	PM_{10}			
Pearce and Crowards (1995) (£ per tonne)	UK	PM_{10}	23288		57748
Beukering et al (1998)	EU	PM_{10}		20468	
ECMT (1998) (ECU/tonne)	UK (rural transport)	PM_{10}		0	
ECMT (1998) (ECU/tonne)	UK (urban transport)	PM_{10}		70000	
CIEMAT 1998 (ECU/tonne)	UK	PM_{10}	8000		22917
Powell et al (1996) (£/tonne)	UK	PM_{10}		8980	
Coopers and Lybrand et al (1997) (ECU/tonne)	UK	TSP (transport)		7522	
Coopers and Lybrand et al (1997) (ECU/tonne)	UK	TSP (electricity generation)		12149	

Table D.A2: Estimates of Damages from Recent European Studies

Study	Study Area	Pollutant	Damage		
			Low	Central	High
AEA (1997) (ECU per tonne)	Birmingham, UK (50m incinerator stack)	SO_2		20131[a]	
AEA (1997) (ECU per tonne)	Birmingham, UK (90m incinerator stack)	SO_2		18715 [a]	
AEA (1997) (ECU per tonne)	Birmingham, UK (100m incinerator stack)	SO_2		18243 [a]	
CIEMAT 1998 (ECU/tonne)	UK	SO_2	6027		10025
Powell et al (1996) (£/tonne)	UK	SO_2		2584	
Coopers and Lybrand et al (1997) (ECU/tonne)	UK	SO_2		4339 [b]	
Davidson and Wit (1998) (£/tonne)		SO_2	2000		4000

[a] Includes acute health, chronic health and materials impacts.
[b] Includes impacts on health, buildings, crops and forests.

Table D.A3: Estimates of Damages from Recent European Studies

Study	Study Area	Pollutant	Damage		
			Low	**Central**	**High**
Krewitt *et al* (1997) (ECU/tonne)	UK/Germany	NO_X	17864		47003
CSERGE (1993) (ECU/tonne)	UK	NO_X		1005 [a]	
AEA (1997) (ECU per tonne)	Birmingham, UK (50m incinerator stack)	NO_X		34739 [a]	
AEA (1997) (ECU per tonne)	Birmingham, UK (90m incinerator stack)	NO_X		34267 [a]	
AEA (1997) (ECU per tonne)	Birmingham, UK (100m incinerator stack)	NO_X		34149 [a]	
ECMT (1998) (ECU/tonne)	UK (rural transport)	NO_X		4000	
ECMT (1998) (ECU/tonne)	UK (urban transport)	NO_X		8000	
CIEMAT 1998 (ECU/tonne)	UK	NO_X	5736		9612
Powell et al (1996) (£/tonne)	UK	NO_X		1270	
Coopers and Lybrand et al (1997) (ECU/tonne)	UK	NO_X		3076 [b]	

[a] Includes acute health, chronic health and materials impacts.
[b] Includes impacts on health, buildings, crops and forests.

Tropospheric Ozone and Volatile Organic Carbon

Key ozone precursors are NO_x and organic carbon (TOC) (see below). It is not always completely obvious whether ozone damages are included in assessments of the damages due to these pollutants. The AEA (1997) report gives a value of 2,530 ECU/tonne of ozone. The CIEMAT (1998) report, acknowledging the complexity of the reactions involved, gives a value for the EU of 1,500 ECU / tonne NO_x. Estimates for damage costs from volatile organic carbons do not always obviously include estimates for creation of tropospheric ozone. For Volatile Organic Carbon compounds, ECMT (1998) use a figure of 4,000 ECU/tonne in rural areas and 8,000 ECU per tonne in urban areas.

Because of the complexity of the chemistry involved, damage estimates are difficult to arrive at. Since, in the contexts we are dealing with, we are looking to understand the ozone-related effects of emissions from NO_x and TOC, we have estimated low and high values of £500 and £2,000 per tonne of NO_x. However, given the enormous range in the damage costs for NOx, we make no adjustment of these figures. For VOCs, we use high and low values of EUR 1,000 and EUR 8,000 (these are suspected of having carcinogenic effects beyond their impacts on crops and health via ozone formation).

Greenhouse Gases (Carbon Dioxide, Methane and Nitrous Oxide)
Evidently, placing values on greenhouse gas emissions presents particular problems. Theoretically, one needs to know how climate will change because of anthropogenic emission of gases (relative to the counterfactual). The uncertainty surrounding climatic projections and the dynamic path by which climate changes, specifically, the frequency and severity of extreme events, makes easy quantification a rather distant prospect.

Carbon Dioxide

Marginal Social Costs for CO_2 emissions from a number of studies are given in Frankhauser and Tol (1995). Note that these vary over time so that typically, the shadow price of a tonne of CO_2 rises over time. Where ranges were given, they were given for 90% confidence intervals. Examples of these are:

- From Nordhaus (1991) $0.3-$65.9;
- From Cline (1992) $5.8-$124; and
- From Fankhauser (1994) $6.3–$45.2.

All these are valued in $1990 and are per tonne of carbon (so for values for CO_2, one has to multiply by the relative molecular weights, that is, 12/44). Other studies include ECMT (1998) which, in the spirit of precautionary approach, used 50,000 ECU / tonne CO_2. Davidson and Wit (1997) (cited in ECOTEC 1999) estimate damage costs at £30 / tonne CO_2. Ecobalance and Dames and Moore (1999) used £3-109 in their recent report for the UK's DTI. The ExtenE programme of research has led to a number of estimates. A recent set is shown in Table D.A4 and we have used the ranges in this Table.

Table D.A4: The marginal costs of carbon dioxide emissions, ExternE 1999

Discount Rate	CO2			1999€ / CO2	1999€ /t C
0%	Low	**142**	**1990$**	148.4	40
0%	High	**325**	**1990$**	339.7	93
3%	Low	**19**	**1995€**	20.7	6

3%	High	**20**	**1995€**	21.8	6
10%	Low	**3**	**1990$**	3.1	1
10%	High	**7**	**1990$**	7.3	2

Note that the pure rate of time preference rate is one component of the discount rate; the other main one which is added is the growth rate of per capita income. The modeller has however assumed a number of different regions of the world so there is no one single discount rate. The approach is therefore not directly comparable with other unit values and it may be best simply to use the maximum and minimum as reasonable ranges - as I have done.

Methane

The two extreme values that we have made use of effectively come from Fankhauser (1995) and Davidson and Wit (1997). Fankhauser's range for a 90% confidence interval is £36.6-136.4 /tonne CH_4 . This was the range used in work done for us by CSERGE in ECOTEC (1999). The same study mentioned the work by Davidson and Wit (1997). Table D.A5 shows recent results from ExternE, we have used these values.

Table D.A5: The marginal costs of methane emissions, ExternE 1999

	CH4	**Unoxidised units (CH4)**		
0%	Low	**504**	**1990$**	526.8
0%	High	**830**	**1990$**	867.5
3%	Low	**300**	**1995€**	326.6
3%	High	**380**	**1995€**	413.7
10%	Low	**24**	**1990$**	25.1
10%	High	**73**	**1990$**	76.3

Nitrous Oxide

Estimates can be found from earlier work carried out for us by CSERGE (in ECOTEC 1999). The values from Fankhauser (1995) cover a 90% confidence range with a low value of £614.30, the high value, £5,534.78 per tonne of N in N_2O. The results from ExternE are shown in Table D.A6 and we have used these values.

Table D.A6: The marginal costs of nitrous oxide emissions according to ExternE 1999

	£/tonne			
0%	Low	**24044**	**1990$**	25131.4
0%	High	**32785**	**1990$**	34267.7
3%	Low	**6400**	**1995€**	6968.2
3%	High	**11000**	**1995€**	11976.5
10%	Low	**197**	**1990$**	205.9
10%	High	**822**	**1990$**	859.2

Carbon Monoxide

The damage costs for carbon monoxide come from Fankhauser (1994). The central estimate as given in Powell et al (1996) is 0.6p/kg, or £6 per tonne. We have used values of £2-£10 per tonne. This is highly arbitrary. However, the influence of carbon monoxide under these assumptions is minimal in our analysis.

Heavy Metals and Dioxins

A fairly comprehensive treatment of benefits assessment associated with heavy metals from incineration plants under different assumptions is given in AEA (1997). The reader is directed there for details of the derivations and the discussions surrounding specific pollutants. The greatest variation is witnessed in the case of dioxins. Here, the assumption concerning the absence or otherwise of thresholds has enormous influence on the results. The values we have used reflect the variation with the assumptions employed by AEA (all values are £/tonne):

- For dioxins, a low of €0, a high of €11 billion;
- For cadmium, a low of €81,500 and a high of €1,141,000
- For arsenic, a low of €9,780 and a high of €6,520,000;
- For mercury, AEA use a value of €0;
- For chromium, a low of €978,000 and a high of €6,846,000;
- For nickel, a low of 17,930 and a high of €733,500.

These reflect not just variation in assumptions about effects, but also stack height (note these were derived for an incinerator in Birmingham).

For lead, we have used a range from EFTEC (1996) of €4890-€14670 per tonne.

CFCs, Water Pollutants incl. Leachate

We do not have data on emissions from any of the treatment routes for CFCs, and we do not feel that the valuation work available allows for an easy quantification of impacts from water pollution. These are omitted from the valuation work undertaken. The above valuation factors can be compared with those used in COWI (2000) (
Table D.A7).

Table D.A7: Valuation estimates of air emissions (EURO per kg emission).

Emission type	Best estimate	Low estimate	High estimate	Estimate based on	Relevant for I/L 1)
CO_2	0.004	0.003	0.005	Study 3 and 4	I & L
CH_4	0.150	0.070	0.303	Study 3 and 4	L

N2O	1.5	1.5	1.5		
Particulates	24	12.5	32.6	Study 1,2 and 3	I & L
SO2	9	4.1	13	Study 1,2 and 3	I & L
NOx	16	3.29	21.455	Study 1,2 and 3	I & L
VOC	1.5	0.757	2.96	Study 1 and 2	I
CO	0.005	0.002	0.009	Study 1 and 3	I & L
As	600	162	1.168	Study 1 and 2	I
Cd	50	20	95	Study 1 and 2	I
Cr	500	133	958	Study 1 and 2	I
Ni	10	3	20.	Study 1 and 2	I
Dioxins	10,000,0000	2,339,717	17,630,080	Study 1 and 2	I & L

Note: 1) The value is used for emissions from I: Incineration, L: Landfill disposal.

ANNEX 2:

COMPOSITION OF MUNICIPAL SOLID WASTE USED IN THE STUDY

These are ‘guesstimates’, but are based on knowledge of the European situation.

Table D.A8(a)

Material	Percentage Composition
Newspaper	15.0%
Office paper	6.0%
Corrugated Boxes	3.0%
Coated Paper	6.0%
Al Cans	1.5%
Steel Cans	2.8%
Glass	2.2%
HDPE	4.0%
LDPE	2.0%
PET	2.0%
Food Scraps	28.5%
Grass	4.0%
Leaves	2.0%
Branches	2.0%
Yard Trimmings	2.0%
Screenings	8.0%
Textiles	2.0%
Misc Comb	7.0%
Mixed MSW	100%

ANNEX 3:

CALORIFIC VALUES OF COMPONENTS OF MUNICIPAL SOLID WASTE

Table D.A8(b)

	USEPA (MJ/kg)
Newspaper	16.78
Office paper	14.35
Corrugated Boxes	14.88
Coated Paper	11.08
Al Cans	-0.74
Steel Cans	-0.42
Glass	-0.53
HDPE	39.46
LDPE	39.46
PET	20.47
Food Scraps	5.91
Grass	5.91
Leaves	5.91
Branches	5.91
Yard Trimmings	4.96
Screenings	2.30
Textiles	3.50
Misc Comb	12.00

NB. Where estimates from one study are not available, we have used the calorific value of the closest matching material (and this is likely to incur errors)

Source: USEPA 1998.

ANNEX 4:

RANGE OF VALUES FOR INCINERATOR EMISSIONS

Table D.A9: A comparison of emissions from incinerators with valid German emission limits

Pollutant	**Germany – 17 BImSchV from 1990 ***	**Number of incinerators meeting the limits**			
		MWIs/3**	**HMWIs/35**	**HIWIs/28**	**Total/66**
	mg/m3				
Solid particles	10.00	3	11	13	27
CxHy	10.00	3	24	23	50
HCl	10.00	2	19	10	31
HF	1.00	3	25	19	47
NOx	200.00	0	25	23	48
SO2	50.00	3	23	21	47
CO	50.00	3	24	21	48
Sum of heavy metals	0.5	3	21	14	38
Dioxins (PCDD/F)	0.1 ngTEQ/m3	1	16	7	24

* *Limit values equivalent to those in the new Waste Incineration Directive 2000/76/EC: Air pollution: incineration of waste (replacing direct. 89/369/EEC, 89/429/EEC, 94/67/EC)*

** *number of incinerators with known emission flows*

Technical Annex 1:

QUANTITATIVE REVIEW OF METHANE EMISSIONS

below). There are differences between the two. This almost certainly reflects different methodological approaches rather than any real change in methane emissions in the years between 1990 and the UNFCC submissions (since in the absence of any radical change in the quantity and nature of the waste fractions that undergo methanogenesis in landfills, the emissions would be expected to be relatively similar).

Table D.A10: Methane Emissions Data from Corinair And UNFCC Inventories (1000 tonnes/year)

	Corinair (1990)	UNFCC (1995)
Bulgaria	62	468.52
Cyprus		0
Czech Rep	34	144
Estonia	NA	31
Hungary	1	0
Latvia	43	44
Lithuania	NA	166
Malta		0
Poland	814	855
Romania	133	228
Slovakia	53	0
Slovenia	32	0
Turkey		0
Total	**1,172**	**1935.62**

The level of inconsistency between such models is highlighted if the IPCC method for national methane emissions is examined. This is often used by countries to estimate their total methane emissions. However, one of the main assumptions is that methane will only derive from landfilling of Municipal Solid Waste (MSW). Methane is given off during the biodegradation process of organic matter and MSW does tend to have a much higher composition of organic waste than non-MSW. However, even though the potential for methanogenesis of MSW may be higher, and even though industrial wastes are often treated through methods other than landfilling, the non-municipal sources of waste are a much higher fraction of the total landfilled (with the exception of small states dependent upon tourism such as Cyprus). Hence, the total contribution to methane production is unlikely to be trivial.

Methane emissions from landfills are not incredibly well understood. They are especially likely to depend on composition. Looking at the USEPA data by material type (see Table D.A11 below), methane generation is sensitive to the distribution of ‘paper’ even across paper and board types, as well as to the distribution across putrescible components, especially the relative proportion of food scraps.

Table D.A11: Methane Emissions By Component, USEPA (1998)

	Methane Yield (ml/dry gram)	**MTCE/wet tonne**
Newspaper	74.2	0.259
Office paper	346	1.207735849

Corrugated Boxes	152.3	0.531613208
Coated Paper	84.4	0.294603774
Al Cans	0	0
Steel Cans	0	0
Glass	0	0
HDPE	0	0
LDPE	0	0
PET	0	0
Food Scraps	300.7	0.335
Grass	144.3	0.214
Leaves	56	0.166
Branches	76.3	0.17
Yard Trimmings		0.191
Screenings		
Textiles		
Misc Comb		
Mixed MSW	92	0.273

A range of estimates for methane emissions per tonne of MSW could be generated from different studies in the public domain. CSERGE et al (1993) looked at estimates from Aumonier and from Warren Spring Laboratory (WSL), and found ranges for best estimates of methane generation of between 53-81 m^3 per tonne of municipal solid waste (MSW). The full range, from the low estimate assuming 20% methane oxidation, to the high estimate from Aumonier, was from 25-117 m^3 per tonne. Powell's (1992) mini-survey estimated recoverable quantities of the order 100 m^3 per tonne (in which case, the actual quantities would presumably be much higher). Entec (1999) on the other hand, used much higher figures of the order 400-500 m^3 landfill gas per tonne of MSW of which 50% was assumed to be methane (i.e. 200-250 m^3 methane per tonne MSW). Using typical waste composition figures for the UK, and the USEPA (1998) methane generation figures in the Table above, ECOTEC (2000) obtained a value of 50 m^3 at 5% oxidation rates, and only 42 m^3 at 20% oxidation rates. It should be noted, therefore, that these are relatively low estimates of methane generation.

Because estimates for methane generation range to such an extent, and also because they are likely to vary considerably between countries based on variables such as composition and climate, this study will take a number of different values for methane generation.

Firstly we will use the UNFCC inventory data for total country methane emissions from landfill, simply because it is more recent than CORINAIR data. However, because we have no basis to compare the relative merits of the methodologies, we will also use a value for methane generation based upon emissions per tonne of waste landfilled. As stated above, there is a wide range of values for methane generated per tonne MSW landfilled and hence this study will use a range bounded by a high and a low value. We have used a range of 25 – 250 m3, which equates to a range of 0.018-0.18 tonnes methane per tonne of waste.

However this range of values for methane generation per tonne landfilled is more likely to be typical of biodegradable components, though as highlighted above, there will be a significant contribution from non-municipal sources of waste. This contribution is not well known. We have used, as an estimate based on experience, a figure of 10% of the non-municipal fraction of waste to use as a multiplier for our estimated methane emissions.

Hence, for each country, we work with three values for methane emissions:

- UNFCC data;
- Our own low estimate; and
- Our own high estimate.

It is worth noting that for many countries, the UNFCC values do fall within the range of our calculated values.

EXTERNAL COSTS ASSOCIATED WITH ENERGY RECOVERY FROM METHANE GAS CAPTURE

For the purposes of this work, in the absence of more detailed information concerning the external costs of these sources, we could have based the 'avoided damages' upon work carried out under the ExternE programme in the context of the German implementation study. That study cites estimates of the externalities from energy generation in the former East Germany (CIEMAT 1999, 148). Taking these estimates and adjusting the 'non-global' impacts using ratios of the purchasing power parity of GDP per capita, one arrives at the results in Table D.A1. However, this approach effectively assumes that in the countries concerned, marginal sources are similar to the mostly lignite fuelled power stations of the former East German Lander that were operating in 1990.

Such an approach is unlikely to be justifiable in this work for a number of reasons:
- The capacity is coming on stream in the future rather than now, during which time, other energy sources may become more clean; and
- The benefits associated with cleaning up the emissions from large combustion plants are effectively studied elsewhere in this report, so attributing a benefit in respect of displacement of the pollution being abated would imply double counting of the avoided pollution.

For this reason, we have reverted back to a situation in which low and high values of the avoided emissions are taken from the ExternE National Implementation Studies (see Table D.A13). These are then adjusted by relative purchasing powers, although this probably leads to an understatement of benefits since a substantial component of the pollution being avoided has a global effect (and should not therefore be adjusted by relative purchasing powers). The high and low values used are € 0.02 and € 0.13 respectively.

Table D.A12: Estimated Avoided Damage Costs Associated with Energy Generation in Different Countries

		BASE	**EU**	**BULGARIA**	**CYPRUS**	**CZECH REPUBLIC**	**ESTONIA**	**HUNGARY**	**LATVIA**	**LITHUANIA**	**MALTA**	**POLAND**	**ROMANIA**	**SLOVAKIA**	**SLOVENIA**	**TURKEY**
		1990€	1999	1999	1999	1999	1999	1999	1999	1999	1999	1999	1999	1999	1999	1999
Mortality		320.20	418.35	92.90	333.57	245.62	144.13	210.12	113.16	121.04	229.55	152.02	111.55	193.46	293.90	122.00
Morbidity		33.50	43.77	9.72	34.90	25.70	15.08	21.98	11.84	12.66	24.02	15.90	11.67	20.24	30.75	12.76
Crops		3.00	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92
Materials		6.10	7.97	7.97	7.97	7.97	7.97	7.97	7.97	7.97	7.97	7.97	7.97	7.97	7.97	7.97
Ozone		4.00	5.23	5.23	5.23	5.23	5.23	5.23	5.23	5.23	5.23	5.23	5.23	5.23	5.23	5.23
Global Warming																
	Low	5.80	7.58	7.58	7.58	7.58	7.58	7.58	7.58	7.58	7.58	7.58	7.58	7.58	7.58	7.58
	High	212.00	276.98	276.98	276.98	276.98	276.98	276.98	276.98	276.98	276.98	276.98	276.98	276.98	276.98	276.98
Occupational Health		0.60	0.78	0.17	0.63	0.46	0.27	0.39	0.21	0.23	0.43	0.28	0.21	0.36	0.55	0.23
TOTALS																
LOW	m€/kWh	373.20	487.60	127.48	393.79	296.47	184.17	257.19	149.91	158.63	278.69	192.90	148.13	238.75	349.90	159.69
HIGH	m€/kWh	579.40	757.00	396.89	663.20	565.87	453.58	526.59	419.31	428.03	548.10	462.31	417.53	508.16	619.30	429.09
LOW	€/GJ	103.67	135.44	35.41	109.39	82.35	51.16	71.44	41.64	44.06	77.41	53.58	41.15	66.32	97.19	44.36
HIGH	€/GJ	160.94	210.28	110.25	184.22	157.19	125.99	146.28	116.48	118.90	152.25	128.42	115.98	141.16	172.03	119.19

Source: Author's calculation based on ExternE 1999

Note: 'Base' is data from the German implementation study results for the 'neue Lander'. These figures (1990€) are converted to 1999€ using a factor of 1.30653 (from Eurostat data) then adjusted using PPP ratios for the countries concerned.

Table D.A13: Externalities from Energy Production in EU Countries

		Austria	Belgium	Germany	Denmark	Spain	Finland	France (2)	Greece	Ireland	Italy	Netherlands	Norway	Portugal	Sweden	United Kingdom
GDP/cap		26108	24541	26217	32752	14786	24938	23954	11561	22921	20680	24921	33174	10969	26863	23684
GDP/cap (PPPs)		23900	23677	23010	25459	17223	21693	21132	14178	22832	21531	24141	27391	15672	21799	21559
PPP (relative to EU)		1.12	1.11	1.08	1.20	0.81	1.02	0.99	0.67	1.07	1.01	1.13	1.29	0.74	1.02	1.01
Coal/lignite	Low		37	30	35	48	20	69	46	59		28		42	18	42
	High		150	55	65	77	44	99	84	84		42		67	42	67
Gas	Low	11	11	12	15	11		24	7		15	5	8	8		11
	High	26	22	23	30	22		35	13		27	19	19	21		22
TOTAL ENERGY	TWh		65.8	417	85	161	61	502	40	16.4	225	82	123	31	138	334
TOTAL EXTERNALITIES	Low		2050	10021	1776	7391	920	4364	3719	720	13000	1522	286	1277	302	17640
	High		5411	17809	2530	9361		5347	5013	1300	16000	2703		1786		22184
ECU PER KWH	Low		0.03	0.02	0.02	0.05	0.02	0.01	0.09	0.04	0.06	0.02	0.00	0.04	0.00	0.05
	High		0.08	0.04	0.03	0.06	0.00	0.01	0.13	0.08	0.07	0.03	0.00	0.06	0.00	0.07
ECU PER GJ	Low		8.65	6.68	5.80	12.75	4.19	2.41	25.83	12.20	16.05	5.16	0.65	11.44	0.61	14.67
	High		22.84	11.86	8.27	16.15	0.00	2.96	34.81	22.02	19.75	9.16	0.00	16.00	0.00	18.45

Source: ExternE 1999

We have not valued the external costs of the emissions from the engine burning the landfill gas. Other studies that have included these in valuations have concluded that their contribution to the externalities of landfill is very small indeed because the emissions themselves are so small (see COWI 2000). This is not to say they might not be considered significant in the future, and indeed, some studies suggest that gas flaring actually does more harm than good. We alluded above to the issue of scientific uncertainty and dioxin emissions are one pollutant where scientific uncertainty in respect of the impacts upon human health appears particularly pronounced.

Technical Annex 2:

ESTIMATING UNIT DAMAGE COSTS FOR TREATMENT PROCESSES

LANDFILL

Landfills emit carbon dioxide as well as methane. By volume, approximately half of landfill gas is usually methane, and the other half is carbon dioxide. CSERGE (1993) carried out an analysis of the externalities from landfill and did not distinguish between the CO_2 emissions that arise from biogenic sources of material and those that do not. The argument given was that this would not alter the analysis significantly. Yet this assumes that the estimates of damage associated with GHGs are fairly well understood (and implicitly, that they are believed to be small). Furthermore, it is a statement that has to be relativised in the context of an analysis, which focuses only on a subset of the total external costs, and where sensitivities in respect of landfill gas collection and combustion are ignored. Collection and combustion of landfill gas has the net effect of converting CH_4 to CO_2, making the question of how one accounts for that proportion of the GHG emissions which emerge as CO_2 rather more important in understanding the effects of switching to increased gas recovery (since more CO_2 is produced, but much of this may be from biogenic sources).

Elsewhere, it has been usual in valuation of the effects of biodegradation under landfill conditions to ignore the releases of CO_2 on grounds that these are emissions which would have occurred anyway (if the material was not landfilled) and that they are part of the carbon being continually cycled. The argument is that these sources of CO_2 are not the consequence of anthropogenic releases into the atmosphere *per se*, but are releases that would have occurred anyway (USEPA 1998). The methane component, on the other hand, can be considered anthropogenic in character (methane is produced because of the conditions that exist in the landfill). It would be consistent with this view not only to ignore the CO_2 emissions from landfill (on the basis that all are biogenic), but also to subtract from any valuation of the emissions of methane from landfill the value of the equivalent emissions of CO_2 which *would* have occurred had the material been biodegrading outside landfill. As far as we can see, this has not been done in any external cost study thus far.

We have relied on estimates of methane emissions from municipal waste, which come from only one source (Barlaz 1998), which is recognised as a problem by the USEPA in its work (from where these estimates are taken – see discussion above). It is interesting to note that some materials are treated as net sequesters of carbon in this model since their carbon is deemed of biogenic origin and is assumed to degrade incompletely in landfills. To account for this, we have used unit damage costs for carbon dioxide from the ExternE programme. As with methane, these vary with the discount rate owing to the fact that CO_2 resides in the atmosphere for some time. The same source as for methane is shown in Table D..

Table D.14: Unit damage costs for carbon dioxide

Discount Rate	CO_2	**Value / t C**	Unit	1999€ / t C	1999 €/t CO_2
0%	Low	**142**	**1990$**	148.4	40
0%	High	**325**	**1990$**	339.7	93

3%	Low	**19**	**1995€**	20.7	6
3%	High	**20**	**1995€**	21.8	6
10%	Low	**3**	**1990$**	3.1	1
10%	High	**7**	**1990$**	7.3	2

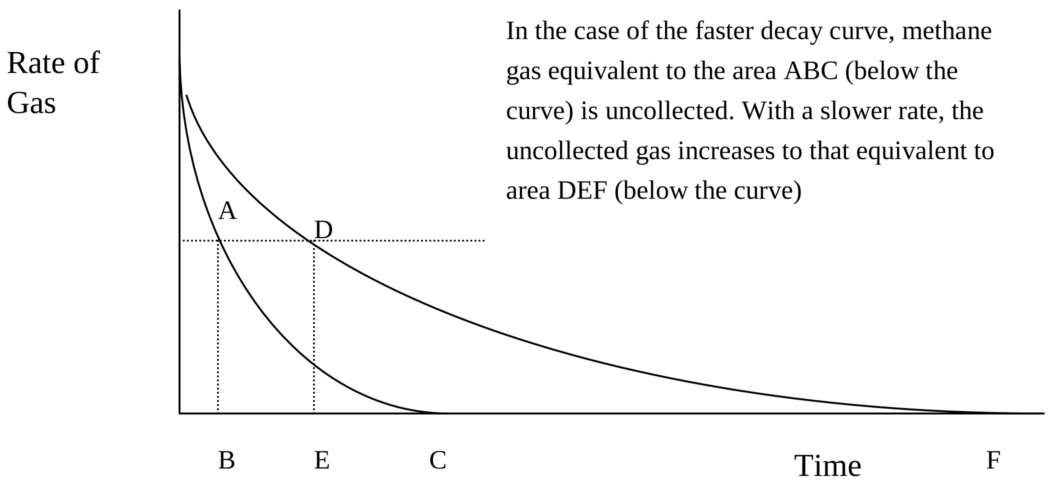
Source: Based on ExternE 1999

The different discounts rates are "real" rather than "nominal" discount rates. For use in this study, it has been converted to 1999 EUR.

To avoid double counting with the benefits from gas collection (see above), we have assumed in this module that no landfill has gas collection systems in place. We have followed the USEPA (1998) assumption concerning the rate at which methane is oxidised through the landfill cap (10%).

In the ideal world, one would model gas generation with more dynamic profiles. The quantities of methane emitted by a specific waste fraction follow an exponential decay rate. As such, attributing methane emissions to a particular tonne of waste as though they occur all in one year will over-estimate the external costs associated with these emissions (other than in the zero discount rate scenario). The nature of waste landfilled also influences the completeness of gas collection, though this is also influenced (for a specific waste fraction) by the period at which one landfills the material relative to closure. This is illustrated graphically in Figure A1 below, in which it is assumed that landfill gas collection becomes 'cost ineffective' below a certain rate (note the curves are drawn for illustrative purposes only and are not intended to be perfect representations of the post-closure situation). The volume of emitted gas is equivalent to the integral under the decay curve once the rate of generation has fallen below the cost-effectiveness cut-off.

Figure A1: Effect of Rate of Gas Generation Post-closure on Uncollected Gas Volumes



In environmental terms, the smaller is the area ABC, then other things being equal, the better will be the performance of the landfill from the point of view of greenhouse gas emissions.

On the other hand, removing paper would, under the USEPA assumptions, remove a net sequester of carbon.

Leachate

The issue of leachate from landfills has been discussed in a recent study for the European Commission (COWI 2000). We agree with their view that there is no robust estimate for externalities from leachate generation. We have followed their approach and used a value for their 'worst case' landfill. The low and high values for leachate, per tonne of MSW landfilled, are €1 and €2. These have been adjusted in accordance with the purchasing power of per capita GDP.

The possibility remains for heavy metals (from, for example, fluorescent tubes) to enter watercourses through breaching landfill liners in the future. This is possibly one example of the 'low probability, high consequence risks', which social theorists have recently sought to come to terms with. It is not clear whether discounting would make these events irrelevant in today's terms. The liabilities being shouldered by some US companies in the context of Superfund programmes are certainly non-trivial, and large enough (possibly reflecting their irreversibility) to make one believe that such liabilities may be enormous should such accidents occur.

Disamenity

Relatively few studies have sought to attribute a value for disamenity associated with landfilled waste. Three reasons can be given:

- Firstly, relatively few studies have been undertaken in Europe. Several have been undertaken in the US, but they refer mainly to hazardous waste landfills (see RPA and Metroeconomica 1999). Examples of European studies are those by Garrod and Willis (1998) and FEEM (cited in CIEMAT 1999). The latter suggested a figure as high as €13.2 per tonne for an Italian landfill, whilst the former quoted residents' willingness to pay to reduce days when disamenity was experienced (approx. €0.3-0.5 per household per day).
- Secondly, the disamenity effects are likely to be heavily influenced by population densities; and
- Thirdly, the disamenity effects of landfills, as with quarries, are likely to be relatively 'fixed' (i.e. they do not change radically as the amount of waste landfilled at the facility increases). As such, because most studies have looked at the impact in terms of the marginal effect of treating an extra tonne of waste, the more or less invariant nature of the impact suggests this is problematic. Attribution of a site's total disamenity will also occur across the total weight landfilled so estimating disamenity per tonne of waste is likely to prove problematic.

Despite these clear problems, we have assigned an impact again following the COWI (2000) study. This estimated a per tonne disamenity externality on the basis of a stylized typical landfill of known capacity. The low and high values are €6 and €19 respectively. These have been adjusted in accordance with the purchasing power of per capita GDP.

INCINERATION

Uncertainties

Similar sources of uncertainty apply regarding the emissions from incinerators as apply to the emissions from other sources of pollution. These points are well made in the Spanish study undertaken in the context of the ExternE programme. Commenting on the uncertainties involved in deriving external cost estimates, the authors state:

Several aspects should be improved, mainly the estimation of global warming damages. Atmospheric dispersion models, which, at least for the Spanish case, should account for the complex topographical conditions are also a controversial aspect. An important issue that should also be studied is the relationship between atmospheric pollution and chronic mortality

Regarding global warming damages, its range of estimated results is so broad that it dominates the results for fossil fuel cycles…
Considering that chronic mortality is, by far, the major externality besides global warming damages for fossil fuel cycles, the fact that there is only one exposure-response function for its estimation, and that this function comes from the US, without being checked in Europe, adds a lot of uncertainty to the final results.
… Controversy still exists around [the issue of valuation of life], and in spite of the modifications introduced in the valuation of life by the Core project, the values assigned are still contested outside the project. (Linares et al 1998)

A particular issue for the valuation of externalities associated with incineration is population density. Hence, in the context of the ExternE project, the following observation was made:

The influence of large cities is shown mainly for the waste incineration plants which are usually placed near or in large cities. This location produces very large damages, as shown especially in the French case, where particulates produce damages around 57,000 ECU/t in the Paris area. These large damages per tonne of pollutant emitted require then that emission factors are kept to the lowest so that the external costs of electricity generated by these plants are not excessive. (CIEMAT 1998).

In Paris, the external costs of MSW incineration were estimated as 52 ECU per tonne of waste excluding CO_2 emissions, and between ECU 67-92 when the CO_2 emissions are included (Spadaro and Rabi 1998). Most of the damage costs were attributable to nitrate and sulphate aerosols. However, these results are raw externality estimates and do not account for displaced externalities associated with the generation of electricity and other energy (which the authors suggest can roughly halve the estimates).

In Italy, the ExternE Implementation study suggests that contrary to the waste management hierarchy, in the (location-specific) case studied, landfill has lower external costs associated with it than incineration. It is not clear that in either case, the avoided externalities associated with potential energy recovery were accounted for, although it is clear that landfill disamenity was accounted for through a specific hedonic pricing study. The net externality (i.e., the amount by which external costs of incineration exceed those of incineration) is given as 7.5 ECU per tonne of waste (Crapanzano et al 1998), an almost complete reversal of the situation found in CSERGE et al (1993) in the UK.

The significance of population densities is reflected in the UK COMEAP recommendations (DH 1998; see also DETR 1999b; IVM et al 1998) regarding exposure-response relationships for specific pollutants. These are expressed in percentage increases in deaths and respiratory hospital admissions per incremental increase in concentration of the pollutant under examination.

Emissions from Incineration

The question of what emissions arise from incineration is obviously central to this part of the analysis. A number of points need to be made here:

- In any plant, the emissions are likely to vary over time. Hence, limit values on plant tend to specify the period over which the measurements must be taken. This makes it somewhat difficult to understand the value that one ought to use in any attempt to evaluate the external costs of such plant. This is especially true to the extent that certain effects might be triggered by threshold values, the excedence of which might be obscured when average values are taken. This limitation to the analysis applies even with more complex approaches to modelling than the ‘externality adder’ one taken here. Furthermore, recent investigations undertaken in Belgium suggest that the emission levels recorded through continuous monitoring approaches (which are not the norm at present) may be a factor of ten or more higher than those that are recorded through periodic measurements;
- There is, in any case, some variation in reported emissions from incineration plant. This will be partly due to the fact that the plants themselves are different, because they use differing technologies to address emissions from the flue gas, and because the wastes they receive may be different too. These may, in turn, lead to different amounts of specific pollutants in the emissions to different media (e.g. wet scrubbers are likely to lead to more emissions of chlorine in the form of effluent than in the form of solid waste, the latter being more likely where dry lime injection is used). Not just the level of emissions, but also the media to which they are discharged, varies with the technology used (the more that is removed from the flue, the more arises in the ash residues);
- As with landfill gas emissions, the emissions from incineration are dependent upon the material combusted. We have less good information here in respect of links between materials and micro pollutants. However, some work has been done on the effects of removing dry recyclables and compostables from the waste stream (Entec 1999a; Atkinson et al 1996). This shows that the calorific value of the remaining waste can be increased when such schemes are in operation, increasing the efficiency of the energy recovery process. Clearly, the removal of organics (because of moisture content), metals

and glass (because both effectively absorb heat) increase the calorific value of the remaining material; and

- Existing MSW incinerators are not likely to meet all the standards likely to become law under the Incineration Directive. Arguably, once the directive becomes law, to the extent that enforcement is effective, emissions will fall in line with what is required by the directive.

Unit Damage Costs

Air Pollution

The unit damage costs for some of the micro pollutants vary enormously between high and low estimates. One reason for this is that there is no unanimous agreement on the existence of thresholds, let alone where any threshold effect might lie. Furthermore, the pathways through which receptors, particularly humans, are exposed to these micro pollutants are not so 'straightforward' as with the direct inhalation of gaseous emissions.

The USEPA (1998) reports measurable quantities of N_2O from incinerators. In common with the other greenhouse gases, we cite the following dataset from the same source as for methane and carbon dioxide (see Table D.).

Table D.A15: Unit Damage Costs for N_2O as Estimated In ExternE 1999.

Discount Rate	**N_2O**	**Value / t**	**Unit**	**1999€/t N_2O**
	£/tonne			
0%	Low	**24044**	**1990$**	25131.4
0%	High	**32785**	**1990$**	34267.7
3%	Low	**6400**	**1995€**	6968.2
3%	High	**11000**	**1995€**	11976.5
10%	Low	**197**	**1990$**	205.9
10%	High	**822**	**1990$**	859.2

4.3.5 Bottom Ash Recovery

The quantities recovered from bottom ash in the Netherlands for 1996 were 33% of all non-ferrous metals and 50% of all ferrous metals (taken as steel). This turns out to be broadly consistent with the figures supplied by the UK's Energy from Waste Association in their response to the Draft Strategy for England and Wales:

'*EfW plants recover both ferrous metals (3-5% of total by weight) and non-ferrous metal (0.5 to 1% by weight - mainly aluminium.) During 1998, the EfW sector is understood to have* *represented the largest single contributor to UK ferrous metal recovery from MSW - in the order of 75,000 tonnes were sent to British Steel for reprocessing.'* (EfWA 1999).

We use 50% of steel (which would generate 3% of total from our composition figures) and the Netherlands figure for aluminium (33%, which is effectively within the 0.5-1% range using our composition figures). Note that the financial benefits from this recovery are less than that associated with materials recovered pre-incineration. This is because the quality of the materials recovered is much lower (owing to contamination from the incineration process), so that whilst materials may be recovered in significant quantities, the quality imposes constraints upon its use.[17]

In the valuation of the benefits from EfW plants using bottom ash to replace the use of primary aggregates, it would be wrong, in our view, to simply multiply the mass of bottom ash by the estimated external costs of primary aggregates extraction (which were quoted, on the basis of Willingness to Pay, for the UK situation in work by London Economics). As discussed both in ECOTEC (1998) and EFTEC (1999), this externality is composed of both variable and fixed elements. EFTEC (1999) estimates the variable component of the total as approximately 55%, or 18p per tonne for hard rock outside national parks, £5.79 for hard rock inside national parks, or £1.08 for sand and gravel. We have attributed benefits on the basis of half the high and low UK estimates, adjusted for the relative purchasing power of per capita GDP.

Note this does no account for any differential transport externalities in transport costs which may arise when one switches from aggregates to bottom ash. Note also that other materials now competing in this market are recycled construction materials and indeed recycled glass. To the extent that one might, at the margin, be replacing secondary aggregates, any additional benefit could (and this is arguable) be reduced to the equivalent of the avoided variable externality associated with secondary aggregates production. Lastly, note that we have not accounted for externalities arising from the removal of contaminants (some of which effectively involves the removal of metals discussed above). Also, heavy metals can be leachable so that in the absence of utilising chemical stabilising agents (at a cost), there may be longer-term effects from the use of bottom ash as substitute for aggregates. These considerations suggest that whilst our analysis suggests a small net benefit, the reality (i.e., if one were able to account for all these impacts) may be rather different.

[17] This will be especially true for aluminium where the desirability of closed loop processes stems from the fact that specific alloys are used for specific purposes. Lack of knowledge concerning the alloy content is likely to reduce the value of the metal considerably (ECOTEC 1999).

RECYCLING

Steel

For steel, we were given access to the International Iron and Steel Institute (IISI) study of steel making processes.[18] The way we have treated this information is as follows:

- We assume that under the 'no recycling' scenario, the steel is landfilled or recovered/landfilled at an energy from waste plant. New steel is produced in a basic oxygen furnace (BOF);
- Under the recycling scenario, the steel is assumed to go to an electric arc furnace (EAF);

This is slightly questionable since in practice, the recovered metal could go to the BOF plant. BOF plants effectively involve two stages in the production of steel, the first involving the melting of (primary) iron from the ore, the second, in which the scrap is added to the furnace to make steel. It is this first stage that accounts for most of the energy used in making steel through the BOF route. In this case, one could compare:

- A secondary route, to which one allocates a fraction x/y of the emissions from the 'iron and scrap' smelting process, where x is the amount of secondary material and y is the total amount of iron and scrap (primary and secondary) material, leading to the production of z tonnes of steel; and
- A primary material route, to which one allocates a fraction x/y of the emissions from the iron melting process, and a fraction x of the emissions from the 'iron and scrap' smelting process used to create one unit of molten iron.

In this case, the emissions from the production of steel through primary material, and an equivalent amount of steel through secondary processing are made comparable.

The second approach is made rather more difficult to handle since the information from IISI comes in the form of averages across a number of plants (with maximum and minimum values from these) of emissions from different processes. Because consistent data across the same the plants are not available, the effect of subtracting the liquid iron emissions from the Gross BOF emissions sometimes generates results which suggest negative emissions from a process where this cannot be the case. Hence, we have resorted to the more straightforward approach through method 1.

Costing Participation

Note that we have not included any costings for the time that householders might spend separating wastes and cleaning them. Depending upon the assumptions made, these can be

[18] We are extremely grateful to those at the Swinden Technology Centre of Corus, especially Louis Brimacombe, who enabled us to make use of the IISI work.

significant factors in determining the viability of source separation schemes. For example, a recent Swedish study has been critical of Swedish policy in respect of recycling (Radetzki 1999). A key reason for this is that the study accounted for the time spent by householders in separating materials on the basis that these should be costed at prevailing wage rates.

There are two reasons why one might question the assumption. The first would be that on basic economic grounds, the suggestion that individuals place equal values on their leisure and work time would appear to imply an assumption that they are able to choose freely the times at which they work, and that their wage rates are determined on an hourly basis. It is not clear that this is always the case. It may be that leisure time is valued in excess of wage rates, but equally, it may be that certain activities are 'discounted' from such a calculus on the basis that they are things that the person engaging in the activity 'should do' anyway. RPA and Metroeconomica (1999) cite a report by Markandya (1998), which valued non-working time at 15% of the gross wage rate (though the basis for the figure is not made clear in the context).

This leads neatly onto the second point, which is basically one, which follows from a more institutionally informed perspective. One might reasonably ask, where possibilities exist to make use of certain materials, why prevailing rights structures should allow citizens the freedom to dispose of materials without giving any thought to source separation. Indeed, some countries have, through legislation, introduced sanctions (or at least, the threat of them) to ensure that source separation routinely occurs. This is tantamount to altering the rights structure facing citizens so that it becomes a duty of citizens to source separate waste materials. This is an entirely defensible position, irrespective of whether materials are used or not, since a) it makes options available which otherwise would not be, and b) through changing the rights structure, what is defined as the acceptable norm is transformed. Elsewhere, such formal sanctions may not be necessary as norms of behaviour change, in which case, the same effect can occur through the medium of informal institutional changes. Under either circumstance, the fact that separating wastes can become a duty (dependent upon the rights structure) makes it more awkward to impute a labour cost element for the activity. In any case, those designing recycling schemes (or for that matter any scheme which seeks to elicit public participation, for example, responsible handling of litter) must make the process easy for the public to participate in to ensure higher rates of participation (and falling costs).

TRANSPORT

Several studies estimating externalities from waste management options assume a ‘typical’ pattern of transport associated with the treatment method. This is somewhat awkward as the mode of transport, the distance travelled and the fuel source can all vary, and there is little sense in speaking of ‘typical distances travelled’ across countries, still less, typical ‘external costs’ associated with, for example, landfill-related transport. In this study, we have ignored transport.

It is commonly held that transport externalities make recycling a bad idea. Two points need to be made here. Firstly, in some urban areas of the UK, battery driven vehicles, which run on the pavement, are being used to collect recyclables. This reduces urban air pollution and congestion / accident related externalities. Secondly, elsewhere, we have looked at the influence of the transport externalities from conventional recycling vehicles and found that this component of external costs is relatively insignificant when compared with the benefits to be gained from recycling (ECOTEC 2000). Furthermore, in some countries, fuel taxes will partly internalise these costs. This is not to say these impacts are not important. They are, and kerbside recycling is increasingly designed with the goal of reducing air emissions, traffic and the risk of accidents very much in mind. It is also not uncommon in Europe to find collection frequencies for residual wastes falling as a consequence of the introduction of schemes, which separate out biodegradable wastes. The logic of this (apart from allowing a quality compost to be produced) is that the residual waste can be left for longer without causing nuisance once the organic fractions have been separated out. Clearly, climate plays an influential role in determining these collection frequencies.

Technical Annex 3:

DERIVATION OF PACKAGING DATA

TOTAL PACKAGING ARISINGS

This study has utilised two different approaches for deriving this data to enable comparison and a degree of reliability.

Approach I: existing candidate country data

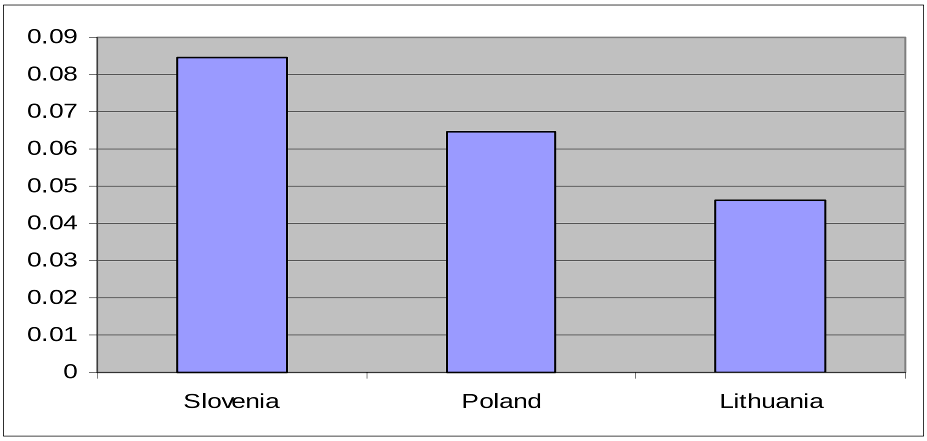
While in general waste data is scarce particularly in the candidate countries, this study has obtained the following total packaging arisings data giving the associated packaging per capita.

Table D.A16: Real packaging arisings

	Slovenia	Poland	Lithuania
Total packaging arisings (tonnes)	168,807	2,495,000	171,000
Total packaging per capita (tonnes)	0.0844	0.0645	0.0462

(Population statistics reference)

Chart D.A1: Real total packaging data per capita (tonnes)



This chart presents the real total packaging arisings per capita data shown in Table D.A16, gathered from Slovenia, Poland and Lithuania. He uses of this data forms the basis of Approach I (described in this section), which estimates the total packaging arisings per capita for the rest of the candidate countries.

This first approach seeks to estimate total packaging arisings per capita for all the other countries involved in the study from this data. One of the implied assumptions in this approach is that the total packaging arisings per capita are likely to be at least similar in the candidate countries because of, for example, their comparative economic development compared with the rest of Europe.

We have examined a number of different methods for doing this.

Average

The first method assumes that the results above are indicative of the fluctuations that will exist between the candidate countries. It makes no attempt to cast judgement on the characteristics of the individual countries themselves and simply assumes that total packaging arisings per capita will not differ significantly. Hence it takes an average of the total packaging arisings per capita data given above and applies it to the rest of the candidate countries.

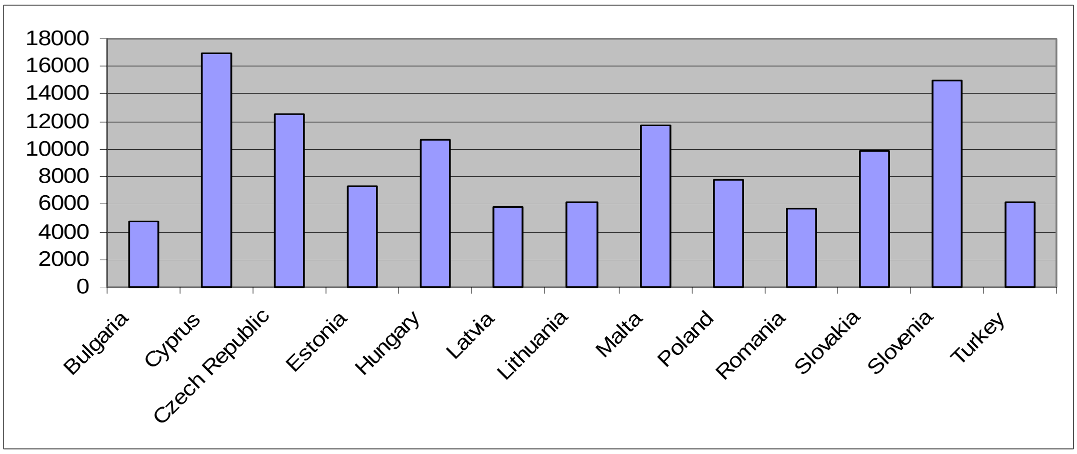
Range

The second method makes allowances for the fact that the total packaging arisings per capita is likely to vary significantly between the member states based on a number of factors. It also acknowledges that predicting the correct values exactly is highly unlikely and therefore obtaining a range is desirable. Hence it uses the high (Poland) and low (Lithuania) total packaging arisings per capita values and calculates a high and low total packaging arisings value for each of the candidate countries.

Groups

The third method takes the view that economic development is closely correlated with packaging waste generation. Examining levels of economic development across the countries in question requires identifying a suitable indicator. While GDP per capita is usually used, this does not take into account purchasing power, which will significantly affect a country's waste generation potential. Hence the following GDP per capita values have been combined with purchasing power parities to obtain an indicator for economic development relevant to this study.

Chart D.A2: GDP per capita PPS (in Euros)



This chart presents GDP per capita for all of the candidate countries, multiplied by purchasing power parities (relative to the EU) to make them directly comparable in terms of a proxy for economic development. These relative heights help derive groups of countries at different levels of economic development.

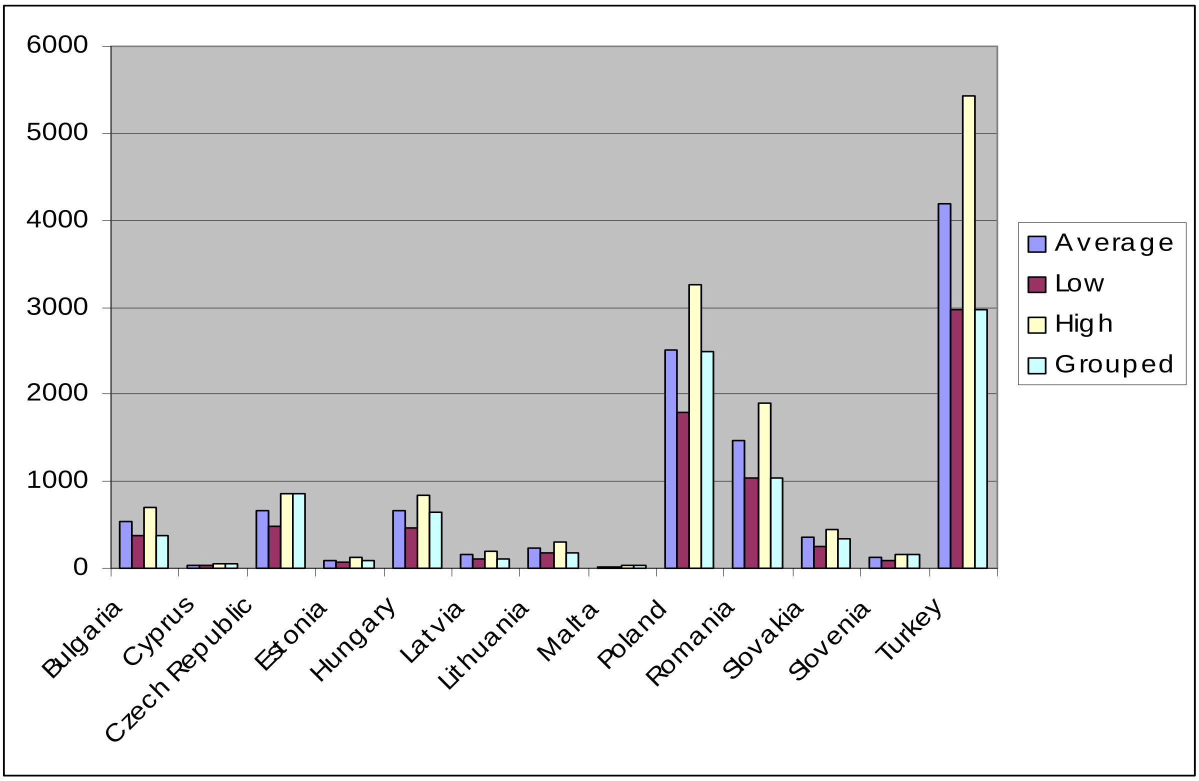
Examining this chart illustrates that the three countries from which this study has been able to obtain data could be used as a proxy for different tiers of economic development: Slovenia in the highest, Poland in the middle and Lithuania in the lowest. If we then group the other countries into three tiers, the following results are obtained:

Tier 1: *Slovenia*, Cyprus, Czech Republic, and Malta.
Tier 2: *Poland*, Hungary, Slovakia, and Estonia.
Tier 3: *Lithuania*, Bulgaria, Latvia, Romania, and Turkey.

The total packaging arisings per capita values for countries in each tier were then taken to be the same, equal to the value for the country where data exists. For example, in tier 1 the total packaging arisings per capita value for all those countries is taken to be equal to that of Slovenia.

The three models give the following values for all the countries in question (the 'low' and 'high' values are derived from the *Range* method as described above):

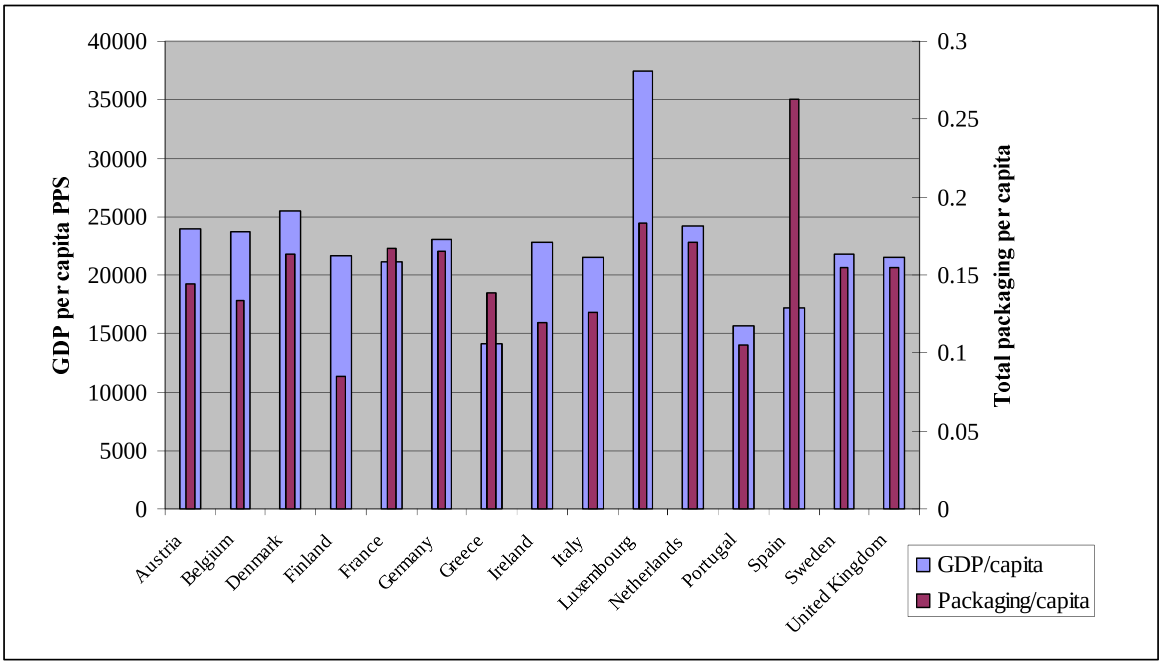
Chart D.A3: Estimated total packaging arising values (in 1000 tonnes)



Each model has a number of advantages and disadvantages. As well as looking at quantitative models for estimating waste data, it is important to put this data into context. The assumption that total packaging arisings per capita would remain constant across the candidate countries is unreliable because of their different situations (economic and social). There are clearly a large number of factors, which will affect packaging waste generation. If it were to be uniquely linked to economic development and purchasing power, then the richest states in the EU might be thought to show the highest total packaging arisings per capita. The following chart shows that a correlation does exist but clearly the situation is more complicated.

There are other important factors such as environmental consciousness and regulation, which will affect the amount of packaging produced (as well as tourism). Setting this aside, there is some support for using this factor to help calculate values where they do not already exist. Hence this study will use the third model (where countries are grouped as to their relative economic development) as an approximation for total packaging for all the candidate countries.

Chart D.A4: GDP per capita PPS with real total packaging per capita



Approach II: using EU packaging data with economic indicators

This second approach builds on the assumption examined above, linking generation of packaging waste with economic development and purchasing power. One of the problems with the third model, chosen in Approach I, is that even though countries are grouped in terms of economic development, for example all the countries in tier 1 will have the same total packaging arisings per capita, economic conditions still vary considerably. Hence this approach uses the approximate correlation identified above, between GDP per capita PPS (i.e. with purchasing power parities built in) and total packaging arisings per capita for the candidate countries. Using a calculated total packaging arisings for the whole of the EU from a recent study on packaging in the EU (from Price Waterhouse), this study calculated an average total packaging arisings per capita for the EU of 0.16 tonnes). The figure was then relativised using the purchasing power of per capita GDP. The results are shown in Table D.A17.

Table D.A17: Calculation of total packaging per capita using GDP per capita and PPS multipliers

	GDP/CAP. (EURO/CAP) (1999)	PPP of GDP (1 PPS = ... national currency units) (1999) (EUROSTAT)	Exchange rate (1EUR =... national currency) (1999 average) (EUROSTAT)	PPP multipliers	Per Capita GDP (in PPS)	Relative to EU	Total Packaging per capita
Bulgaria	1,413	0.58	1.96	3.35	4728.7222	0.22	**0.0362**
Cyprus	12,782	0.44	0.58	1.33	16979.662	0.80	**0.1302**
Czech Republic	4,842	14.29	36.89	2.58	12502.423	0.59	**0.0959**
Estonia	3,190	6.80	15.65	2.30	7336.3834	0.34	**0.0562**
Hungary	4,509	106.57	252.77	2.37	10695.335	0.50	**0.0820**
Latvia	2,344	0.26	0.64	2.46	5760.2163	0.27	**0.0442**
Lithuania	2,703	1.87	4.26	2.28	6161.295	0.29	**0.0472**
Malta	8,786	:	0.43	1.33	11684.755	0.55	**0.0896**
Poland	3,743	2.04	4.23	2.07	7737.9851	0.36	**0.0593**
Romania	1,420	4088.74	16345.20	4.00	5678.3264	0.27	**0.0435**
Slovakia	3,281	14.70	44.12	3.00	9847.4907	0.46	**0.0755**
Slovenia	9,416	122.40	194.47	1.59	14960.298	0.70	**0.1147**
Turkey	2,840	204531.00	447230.00	2.19	6210.0741	0.29	**0.0476**

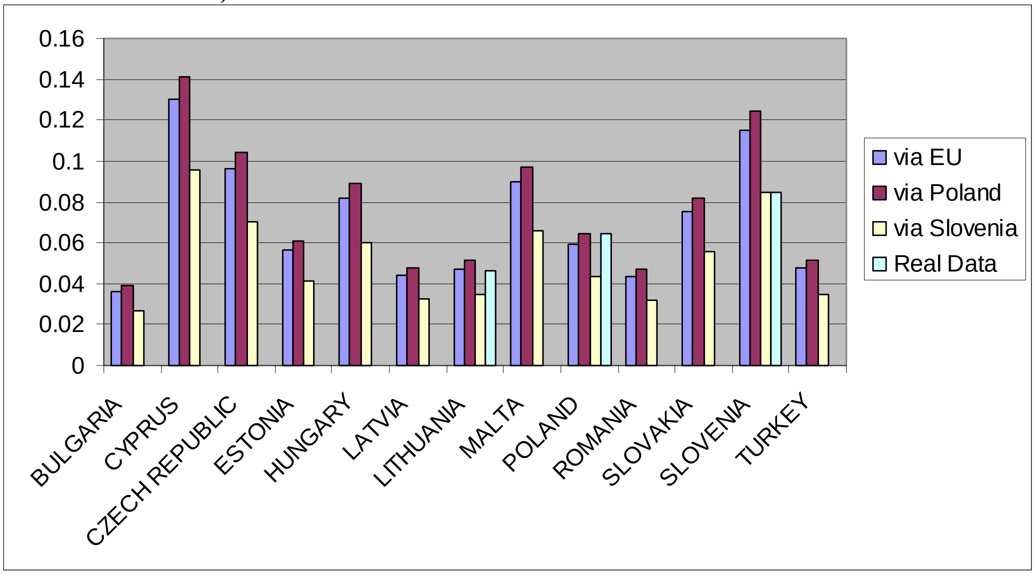
We also attempted a number of other methods under this approach to address the argument that EU data would not be at all relevant to candidate countries and so attempts to model on it would not be reliable. Hence instead of only using the average EU total packaging arisings per capita and GDP per capita PPS versus the EU average, we carried out the same calculation relative to Poland and Slovenia. This was done using their total packaging arisings per capita values, calculating the GDP per capita PPS for all candidate countries relative to these countries, and then combining them to acquire total packaging arisings per capita values for all these other candidate countries. All these calculations gave the following chart (the real data is also included).

From the chart it seems that it is the calculation based on EU data that always lies within the total range. We will therefore use this data alongside the ‘grouped country’ data described above.

Final Range

Hence from the two approaches we have different total packaging arisings per capita values for the candidate countries. The chart above compares them and illustrates how they are often quite similar. This is a good indication given the difference in the modelling approach. Hence this study will use both values for each country to give a possible range even if, in some cases, this range will be quite small.

Chart D.A5: Total packaging arisings per capita from three different methods with real data for Poland, Slovenia and Lithuania



PACKAGING COMPOSITION

As stated previously, there is also limited data on packaging composition from the candidate countries. It was not possible to model differences in composition between groups of countries in this case because there are too many variables. Hence the objective was to estimate an average packaging composition from the existing data, and apply that to the remainder of candidate countries. This starts with an analysis of the existing data from the three countries where data exists.

Table D.A18: Data on packaging waste composition for Slovenia, Poland and Lithuania

	Slovenia		**Poland**		**Lithuania**	
	Tonnes	%	Tonnes	%	Tonnes	%
Glass	23809	14.1	900000	36.1	44000	25.7
Plastics	25283	15.0	250000	10.0	21000	12.3
Paper	79524	47.1	1000000	40.1	98000	57.3
Metals	12430	7.4	170000	6.8	8000	4.7
Wood	23837	14.1		0.0		
Other	3924	2.3	175000	7.0		

In general the main recognisable fractions of packaging waste are glass, plastics, paper and metals. The 'other' component can vary substantially in terms of definition and often data on constituents such as wood is scarce. Hence this study attempted to establish an average composition of glass, plastic, paper and metals relative to each other, before bringing in the 'other' component. This gave rise to the following compositional data (we have included some countries from the EU as a means of comparison).

Table D.A19: Estimation of packaging composition across candidate countries

(%)	**Slovenia**	**Poland**	**Lithuania**		**Denmark**	**Germany**	**Ireland**		**Estimated composition**
Glass	16.9	38.8	25.7		26.8	33.4	17.5		**26**
Plastics	17.9	10.8	12.3		19.6	13.6	25.2		**16**
Paper	56.4	43.1	57.3		49.2	46.2	52.7		**50**
Metals	8.8	7.3	4.7		4.3	6.8	4.6		**8**

Comparison between the existing data from the candidate countries gave rise to the estimated composition percentages given in the right hand column. These agree quite well with the EU examples in terms of averages. However, it is recognised that this approach has a number of significant problems because packaging waste will depend a great deal on the culture of the country, consumption pattern, the can-lines in place in country, etc. and therefore can vary substantially. However, given the data available, this was one of the only reliable alternatives.

Technical Annex 4:

INCINERATION LEVELS AND EMISSION LIMITS IN THE CZECH REPUBLIC

INCINERATION DATA

As stated above, the following data is taken from the following report: **Waste incinerators in the Czech Republic and their impact upon the environment and public health, *Children of the Earth, Prague, February 10, 2000.***

The state administration, the Czech Environmental Inspection (CEI) and the Ministry of the Environment (ME) provided most data about the emissions of pollutants from monitored sources of pollution and the emission and environmental concentrations of selected pollutants. The situation is, understandably, not straightforward where one is seeking information from operators of sources of pollution but here things have begun to change for better. While some polluters refuse to give information on grounds of commercial confidentiality, others give the requested information without any complications. A final important source is the incomplete, yet useful catalogue of incinerators prepared by the firm NSO. Most of our data on operational conditions and technologies of incinerators are based on this catalogue.

Amount of waste incinerated (by type of waste).

Table D.A20: Waste incinerators in Czech Republic by type (1999)

Type	Number	Planned capacity (t/y)	Amount of waste burned (t/y)
MWIs	3	616 000	412 000
HMWIs	44	42 000	23 000
HIWIs	50	130 000	65 000
Total	**97**	**788 000**	**500 000**

MWIs - municipal waste incinerators
HMWIs - hazardous medical waste incinerators
HIWIs - hazardous industrial waste incinerators

Current emission levels (relative to Directive limits).

There are many ways to evaluate emissions from incinerators. The first approach is simply to add up known emission flows. However, because of the absence of data, such addition would not adequately represent the incinerators as a whole. (Table D.A21)

Table D.A21: Known yearly emission flows of selected pollutants by source type

Pollutant	MWI (3)*	HMWI (45)	HIWI (56)	Total (104)
PCDD/F (mg TEQ/y)	1 556.42 (3)**	1706.45 (23)	1199.96 (34)	4462.83 (60)
PCB (mg/y)	---	---	---	---
PAH (t/y)	3.1 (3)	2.17 (28)	3.32 (28)	8.59 (59)
SO2 (t/y)	48.06 (3)	10.94 (28)	71.05 (31)	130.05 (62)
NOx (t/y)	595.07 (3)	48.31 (28)	153.33 (31)	796.71 (62)
CO (t/y)	54.21 (3)	10.52 (28)	124.36 (31)	189.09 (62)
TZL (t/y)	2.03 (3)	7.77 (28)	39.42 (31)	49.22 (62)
HCl (t/y)	14.38 (3)	4.72 (26)	6.68 (28)	25.78 (57)
HF (kg/y)	216 (3)	323.21 (26)	557.14 (26)	1096.35 (55)
Cd+Hg+Tl (kg/y)	62.67 (3)	29.7 (29)	127.51 (29)	219.88 (61)
As+Co+Cr+Ni (kg/y)	61.87 (3)	571.21 (28)	332.5 (30)	965.58 (61)
Cu+Mn+Pb (kg/y)	25.89 (3)	378.64 (29)	1886.42 (32)	2290.95 (64)

Note: * number of incinerating units (incinerators and incinerator furnaces) in the group
** number of Ius with known emission flows
MWIs - Malešice (1999), Brno (1997)

The second possibility is to estimate the total emissions from all incinerators on the basis of known emission flows (Table D.A22). This table makes it possible to compare absolute amounts of pollutants produced by individual types of incinerators as well as by all incinerators in relation to other sources of pollution.

Table D.A22: Maximum yearly emission flows of selected pollutants by source type (estimate)

Pollutant	MWIs (3)	HMWIs (45)	HIWIs (56)	Total (104)
PCDD/F (mg TEQ/y)	1 556 **	1990 - 3339	1976	5522 – 6871
PCB (mg/y)	---	---	---	---
PAH (t/y)	3	4	6	13
SO2 (t/y)	48	18	110 - 128	176 – 194
NOx (t/y)	595	78	236 - 277	909 – 950
CO (t/y)	54	16	140 - 225	210 – 295
TZL (t/y)	2	11 - 13	71	84 – 86
HCl (t/y)	14	8	12 - 13	34 – 35
HF (kg/y)	216	490 - 559	823 – 1200	1529 – 1975
Cd+Hg+Tl (kg/y)	63	46	174 - 246	283 – 355
As+Co+Cr+Ni (kg/y)	62	626 - 918	620	1308 – 1600
Cu+Mn+Pb (kg/y)	26	469 - 588	2434 – 3301	2929 – 3915

Notes:
** rounded to whole numbers
MWIs - Malešice (1999), Brno (1997)

Table D.A2 brings a comparison of emission factors (emission flows per ton of burned waste) on the basis of real performance of incinerators. These performance standards can be compared with the existing Czech and German standards.

Table D.A23: Maximum yearly emission flows of selected pollutants per ton of burned waste by source type

Pollutant	MWIs (3)* 412 000 t/r	HMWIs (45) 23 000 t/r	HIWIs (56) 65 000 t/r
PCDD/F (ug TEQ/t)	3.77**	86.52 - 145.17	30.4
PCB (ug/t)	---	---	---
PAH (kg/t)	0.01	0.17	0.09
SO2 (kg/t)	0.12	0.78	1.69 - 1.97
NOx (kg/t)	1.44	3.39	3. 63 – 4.26
CO (kg/t)	0.13	0.70	2.15 - 3.46
TZL (kg/t)	0.00	0.48 - 0.57	1.09
HCl (kg/t)	0.03	0.35	0.18 - 0.20
HF (g/t)	0.52	21.30 - 24.30	12.66 – 18.46
Cd+Hg+Tl (g/t)	0.15	2.00	2.68 - 3.78
As+Co+Cr+Ni (g/t)	0.15	27.22 - 39.91	9.54
Cu+Mn+Pb (g/t)	0.06	20.39 - 25.57	37.45 – 50.78

Notes: * number of IUs in the group; ** rounded to two decimal places
MWIs - Malešice (1999), Brno (1997)

Table D.A24: A Comparison of Emissions from Incinerators with Valid Czech Emission Limits

Pollutant	Czech Republic - decree no. 117/97 Coll.	Number of incinerators meeting the limits			
		MWIs/3*	**HMWIs/35**	**HIWIs/28**	**Total/66**
	mg/m3				
Solid particles	30.00	3	23	21	47
CxHy	20.00	3	27	26	56
HCl	30.00	3	26	26	55
HF	2.00	3	26	24	53
NOx	350.00	3	29	27	59
SO2	300.00	3	30	27	63
CO	100.00	3	28	25	56
Cd+Tl+Hg	0.2	3	33	27	63
As+Ni+Cr+Co	2.0	3	34	27	64
Pb+Cu+Mn	5.0	3	33	28	64
Dioxins (PCDD/F)	None				

* number of incinerators with known emission flows

THE BENEFITS OF COMPLIANCE WITH THE ENVIRONMENTAL ACQUIS FOR THE CANDIDATE COUNTRIES

PART E: NATURE PROTECTION DIRECTIVES

PART E: NATURE PROTECTION DIRECTIVES

Contents

PART E: NATURE PROTECTION DIRECTIVES

Part E of the Benefits Sub-study identifies and assesses qualitatively and quantitatively the main benefits expected from the implementation of the Habitats and Wild Birds Directives in the Candidate Countries.

The analysis covers a brief description of the requirements of the Habitats Directive (Section 1), an overview of current biodiversity status and major threats to biodiversity in the Candidate Countries (Section 2), qualitative assessment of benefits (Section 3) and quantitative assessment of benefits (Section 4).

The main assumption behind the analysis is that the Candidate Countries will by the date of accession (unless transition periods are granted), fully implement the requirements of the Habitats and Wild Birds Directives. Given that Special Protection Areas for birds - required to be set up by the Wild Birds Directive - will be part of the Natura 2000 network (to be established under the Habitats Directive), the benefits from the implementation of the Wild Birds Directive have not been explicitly assessed. These are contained in the analysis of the Habitats Directive.

1 INTRODUCTION

1.1 The Habitat Directive

The Habitats Directive requires the setting up of Sites of Community Importance (SCIs) under which certain natural habitat types and species of fauna and flora will be protected.

The fundamental objective of the Directive is the establishment, by the year 2004, of a network of protected SCIs throughout the EU: Natura 2000. The Natura 2000 Network is designed to maintain both the distribution and abundance of threatened species and of terrestrial and marine habitats. A SCI is defined by the Directive as a

'...site which, in the biogeographical region or regions to which is belongs, contributes significantly to the maintenance or restoration at a favourable conservation status of a natural habitat type in Annex I or of a species in Annex II of the Directive and may also contribute significantly to the coherence of the Natura 2000 network...and/or contributes significantly to the maintenance of biological diversity within the biogeographic region or regions concerned'.

The Habitats Directive contains four Annexes. Annexes I and II list EU sites and species of Community Importance:

- **Annex I** lists sites hosting natural habitat types of community interest whose conservation requires the designation of special areas of conservation, e.g. estuaries, vegetated sea cliffs of the Mediterranean coasts, alpine rivers and the herbaceous vegetation along their banks, natural and semi-natural grassland formations and forests of temperate Europe.
- **Annex II** lists sites, animal and plant species of community interest whose conservation requires the designation of special areas of conservation.
- **Annex III** provides the criteria for selecting sites eligible for identification as sites of community importance and designation as special areas of conservation. Stage 1 requires an assessment at national level of the relative importance of sites for each natural habitat type in Annex I and each species in Annex II.
- **Annex IV** provides a list of animal and plant species of community interest in need of strict protection.
- **Annex V** provides a list of animal and plant species of community interest whose taking in the wild and exploitation may be subject to management measures.
- **Annex VI** lists the prohibited methods and means of capture and killing and modes of transport for mammals and fishes.

Amendments to Annexes I and II of the Habitats Directive are expected in the near future in order to include species and habitats of importance to the Candidate Countries and to an enlarged Union. Some of the Candidate Countries are currently putting forward preliminary proposals for species and habitats to be included in the Annexes. However, all Candidate Countries are expected to do so by the date of accession. After approval by the Commission of the amended Annexes, Candidate Countries will have to designate within six years 'Special Areas of Conservation' (SACs) to be included into Natura 2000 network.

2 NATURE PROTECTION AND BIODIVERSITY THREATS IN THE CANDIDATE COUNTRIES: AN OVERVIEW

This section will present main biodiversity features and threats to biodiversity in the Candidate Countries. Where information easily available, country examples are given.

2.1 Current status of biodiversity

The natural environment in the candidate countries combines contrasting features such as very polluted hot-spots inherited from the communist past and relatively large areas of natural and semi-natural ecosystems (mainly forests) that host a remarkable biodiversity of species, many of them endemic. Main indicators used to assess the current state of nature protection and biodiversity in the candidate countries include:

- Size of protected areas (expressed as % of country surface area and number)
- Estimates of the expected growth in protected areas (where data available)
- Species status: total number, endemic and threatened species and species density

These indicators, which should be taken only as a rough indication of the nature protection and biodiversity status in the Candidate Countries, are summarized in Tables E.1 and E.2. The surface area covered by protected areas (as % of total country area) is graphically presented in Fig. E.1. Data presented has been obtained from two sources: 1) IUCN database on protected areas 2) data provided by the Candidate Country experts. The IUCN categories[1] referred to in Table E.1 are presented in below (Box 1). Internationally protected areas such as Biodiversity Reserves, World Heritage Sites and Ramsar Convention Wetlands were added to the IUCN categories.

Box 1 IUCN Protected Areas: I-V Management Categories

Protected Areas: Characteristics and Access	
Category I:	***Strict Nature Reserves***: scientific research and educational use
Category II:	***National Parks:*** ecosystem protection, recreation and study
Category III:	***Natural Monuments:*** conservation of a specific/unique natural features
Category IV:	***Managed Nature Reserves/Wildlife Sanctuaries:*** conservation of a particular animal or plant species
Category V:	***Protected Landscapes and Seascape***: landscape/seascape protection and recreation use. May include cultural landscapes

Source: IUCN (2000)

[1] The IUCN classification, as presented in Box 1, includes three more categories: *Resource Reserves, Anthropological Reserves,* and *Managed Resource Areas*. Under these management categories, economic activities (i.e. resource extraction) carried out in a sustainable manner are allowed (IUCN, 1998).

A brief overview of biodiversity and nature conservation status in the Candidate Countries is provided below:

Bulgaria: Though a relatively small country, Bulgaria is often classified as one of the richest countries in Europe from point of view of biodiversity. 37 % of its territory is covered by forest. About 5% of all species of flora are endemic. The network of (declared) protected areas covers almost 5% of the country and includes: 3 national parks, 9 natural parks, 90 reserves, 17 biosphere reserves (more than in any other Candidate Country) and about 22 Important Bird Areas. Most of these protected areas are clustered in the Rhodope and Balkan Mountains.

Cyprus: Cyprus hosts (a) two Mediterranean SPAs on the southern coast which are important habitats for migratory birds (b) a marine reserve, important nesting site for the Green and Loggerhead turtles.

Czech Republic: The Czech nature protection strategy established a comprehensive system of protected areas mainly national parks covering 10,274 km^2.

Estonia: Estonia's protected areas cover approximately 629,000 ha, approximately 12% of the country surface area. Forests and semi-natural areas cover around 55% of the country. 10 protected species in Estonia are also included in the IUCN Red Book; few of them are extremely rare e.g. Pearl mussel and European mink.

Hungary: In Hungary, there are several protected areas, covering about 5,188 km^2 and representing nearly 6% of the country's area the largest part of which is forested areas. There are also several designed Ramsar sites (Hortobay, wetlands on the Tisza, Kis-Balaton).

Latvia: 44% of Latvian territory is forested. There are four marine sites of international importance. Important Bird Areas and two Ramsar sites exist along the coast, which are important sites for migratory birds. Latvia hosts significant populations of globally threatened species.

Lithuania: Natural and semi-natural vegetation cover about one third of the surface area. There are 79 protected areas that occupy 646,000 ha and represent 10% of the surface area.

Malta: The most significant biodiversity assets of the Maltese islands are the 25 bird species and habitats for migratory birds. In 1993, 26 marine areas and 16 coastal areas were recommended as Nature Reserves. Currently Malta has no marine protected areas.

Poland: Poland has 106 protected areas that cover 9.6% of its territory. Forests account for most of the protected areas and represents 28% of total country area. 12% of the plant species and 36% of animal species are endemic According to the WWF, Poland has about 100 wetland Important Bird Areas (IBAs) that host some of the largest populations of some wetland birds such as the White Stork. Several globally, and European threatened bird species are dependent on the wetlands of Poland for their survival.

Romania: Romania has a high and unique level of biodiversity and intact ecological systems. 47% of the country surface area is covered by natural and semi-natural ecosystems. The Danube Delta, the largest delta in Europe, is a special ecological system (Ramsar site and world natural heritage) with vast reed beds and approximately 1,150 species of plants. The Carpathians Mountains have a high density of large carnivores and extensive forests. 40% of the European wolf population and 60% of the brown bear populations are found in Romania. Romania has a National Network of Protected Areas, which included 586 items and which covers about 4.8% of Romania's territory.

Slovenia: Slovenia is a country with a rich biological diversity. About 53% its territory is covered with forest, ranking the country among the most forested in Europe. Slovenia has few protected areas and only one national park, covering 8 of the national territory According to the draft natural conservation strategy, Slovenia aims to expand its protected areas to 20% of its territory.

Slovakia: With the area of 1,991,463 ha, Slovakia is one of the most forested countries in the candidate countries (40.6% of the area). Amongst national protected areas, of special importance are five national parks, covering 199,724 (4 %) and sixteen protected areas in the countryside covering 660,493 ha (13.4% of the Slovak territory).

Turkey: Turkey has a considerable biodiversity of species and habitats. Important ecosystems are the old and mixed forests in the Eastern and Western Black Sea area and Mediterranean forests. Protected areas cover 1,071 thousand hectares or about 1.4% of the country's surface (though according to the WWF in Turkey, protected areas cover less than 1%). Turkey has a rich flora: approximately 9,500 species, of which 35% are endemic.

Table E.1: Protected Areas in the Candidate Countries: Present and Future Areas

COUNTRY	SURFACE AREA (km²)	PROTECTED AREA (1990)		ALL PROTECTED AREAS (IUCN CAT.I-V) (1997)			INTERNATIONAL PROTECTED AREAS (1997)			TOTAL PROTECTED AREAS (1997)			PROTECTED AREA: 2020 PROJECTION	
		Area (km²)	% of country area	Area (km²)	% country area	No.	Area (km²)	% of country area	No.	Area (km²)	% of country area	No	Area (km²)	% of country area
BULGARIA	110,990	:	:	4,910	4.4%	49	690	1%	24	5,600	5%	73	*8,324.25*	7.5%
CYPRUS	9,251.00	:	:	780	8.4%	10	:	:	:	~780	~8.4%	~10	:	:
CZECH REPUBLIC	78,870	10,673	*14%*	12,230	15.8%	44	4,370	6%	15	16,600	21%	59	:	:
ESTONIA	45,227	3,230	*7%*	5,070	11%	53	2,160	5%	11	7,230	16%	64	8,300	18.3%
HUNGARY	93,030	:	:	6,290	7%	54	2,790	3%	25	9,080	10%	79	:	:
LATVIA	64,589	4,262.87	*7%*	7,750	12.5%	45	430	0.67%	~3	8,180	13%	~48	:	:
LITHUANIA	65,300	3,092	*5%*	6,460	10.0%	79	500	0.77%	~5	6,960	11%	~84	11,101-14,366	17-22%
MALTA	315	0.063	*0.02%*	3.11	1.0%	7	:	:	:	~57.04 (1999)	~18% (1999)	:	88.8	28%
POLAND	312,680	:	:	29,110	16.0%	106	2,590	0.8%	16	31,700	10%	122	:	:
ROMANIA	238,391	:	:	10,740	4.7%	39	12,610	5%	4	23,350	10%	43	:	:
SLOVAKIA	49,040	:	:	10,460	21.8%	41	2,290	5%	12	12,750	26%	53	:	:
SLOVENIA	20,273	1,535	*8%*	1,150	5.7%	14	10	0.05%	2	1,160	6%	16	6,400	32%
TURKEY	779,880	:	:	10,710	1.4%	49	760	0.10%	6	11,470	1%	55	:	:
TOTAL	**1867836**	**22 793**	**1,2%**	**105 663**	**5,7%**	**590**	**29 200**	**1,6%**	**115**	**134080**	**7,2%**	564	**N/A**	**N/A**

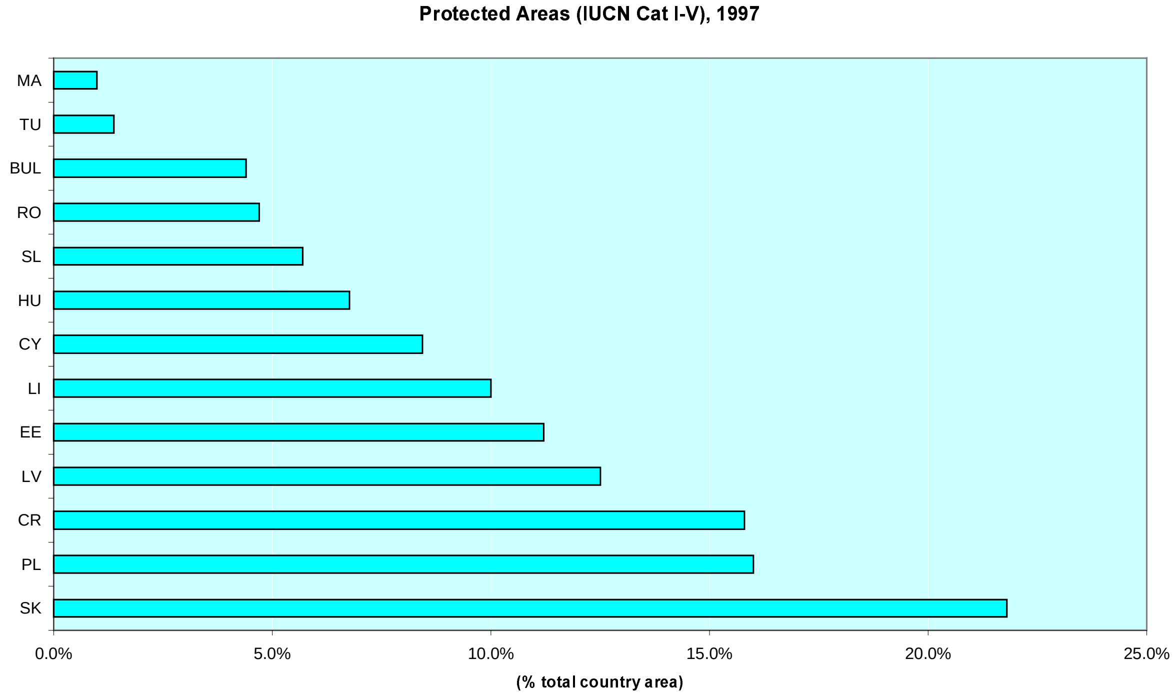
Source: World Conservation Monitoring Centre (1998-1999) & Candidate Countries Experts

Table E.2: Species of Mammals, Birds and Higher Plants in the Candidate Countries (1997)

COUNTRY	SPECIES																	
	MAMMALS						BIRDS						HIGHER PLANTS					
	Total known	Endemic	% Total	Threatened	% Total	Density	Breeding species	Endemic	% Total	Threatened	% Total	Density	Total known	Endemic	% Total	Threatened	% Total	Density
BULGARIA	81	10	12,3%	13	16,0%	37	240	0	N/A	12	5,0%	108	3,505	320	9,1%	94	2,7%	1584
CYPRUS	:	:	NIA	:	NIA	:	:	:	N/A	:	N/A	:	:	:	N/A:	:	N/A	:
CZECH REPUBLIC	:	:	N/A	7	N/A	:	199	0	N/A	6	3,0%	101	:	:	N/A:	3	N/A	:
ESTONIA	65	0	N/A	4	6,2%	40	213	0	N/A	2	0,9%	130	1,630	:	N/A:	2	0,1%	992
HUNGARY	72	0	N/A	8	11,1%	34	205	0	N/A	10	4,9%	98	2,148	38	1,8%	24	1,1%	1029
LATVIA	83	0	N/A	4	4,8%	45	217	0	N/A	6	2,8%	117	1,153	:	N/A	0	N/A	623
LITHUANIA	68	0	N/A	5	7,4%	37	202	0	N/A	4	2,0%	109	1200	:	N/A	0	N/A	646
MALTA	:	:	N/A	3	N/A	:	:	:	N/A	1	N/A	:	:	:	N/A	0	N/A	
POLAND	84	0	N/A	10	11,9%	27	227	0	N/A	6	2,6%	72	2,300	3	0,1%	27	1,2%	738
ROMANIA	84	0	N/A	16	19,0%	29	247	0	N/A	11	4,5%	87	3,175	41	1,3%	122	3,8%	1116
SLOVAKIA	:	0	N/A	8	N/A	:	209	:	N/A	4	1,9%	124	:	:	N/A	:	N/A	:
SLOVENIA	69	0	N/A	10	14,5%	55	207	0	N/A	3	1,4%	164	:	:	N/A	11	N/A	:
TURKEY	116	1	0,9%	17	14,7%	655	302	:	N/A	11	3,6%	:	9,000	3,000	33,3%	1,827	20,3%	66
TOTAL	722	11	1,5%	105	14,5%	N/A	2468	0	N/A	76	3,1%	N/A	24111	3402	14,11	2110	8,8%	N/A

Source: World Conservation Monitoring Centre (1998-1999) & Candidate Country Experts.

Fig. E.1 Protected Areas as Percentage of Total Country Area, 1997



Source: World Conservation Monitoring Centre (1998-1999) & Candidate Countries' Experts.

2.2. Threats to biodiversity

Some of the major threats to biodiversity in the Candidate Countries are presented below. These have been differentiated in direct and indirect threats. Examples include:

a) *Direct threats:*

- Habitat loss and fragmentation due to urbanization, infrastructure development and extraction of natural resources:
  - Water drainage affects aquatic ecosystems in Bulgaria and the Verkne River Valley in Lithuania;
  - Peat extraction threatens aquatic ecosystems in Bulgaria and the Sulinkiai Peatland in Lithuania;
  - Dams are a threat to biodiversity in Turkey and the neighbouring countries (i.e. dams on the Tigris). In Poland, the upper and lower wetland areas of the Vistula Valley - recognized as an important European ecological corridor – have been significantly altered by dam construction;
  - Flood defence poses pressure on Poland's wetland habitats;
  - Uncontrolled developments are a significant threat to biodiversity in Turkey. Poorly planned developments have already lead to the loss of 1,300,000 ha. of wetlands, 87% of the peatlands, 88% of the old forests of Northeast Anatolia,

79% of sand dunes in Istanbul area and 75% of sweet gum forests (WWF – Turkey, 2000).

- Mining resulted in a very poor water quality of the Vistula River, a major ornithological sanctuary and European ecological corridor with over 180 breeding birds.
- Intensive logging threatens the Birzai Forest in Lithuania and the Carpathian forests in Romania;
- Loss of groundwater in Romania as a result of hydro technical works resulted in total or partial drying out of 20,000 hectares of forest.

➢ Transport:

- Coal transport is a serious threat to the Vistula River. Moreover, the East-West Waterway project aimed at channelling 864 km of the Vistula River will destroy and fragment river bank habitats, threaten old river beds, pristine sandy islands etc.

➢ Over-exploitation of ecosystems and species:

- Hunting and collection threatens species of snakes, lizards, marine mammals and coral banks in Malta and endangered species in Bulgaria;
- Overgrazing in Romania reduces soil resources which contributes to severe erosion and ecosystem degradation;

➢ Industrial agriculture:

- The development of monocultures of forests and crops in Poland replaces small ponds, semi-flooded areas that contain rare wetland species. Wet meadows such as those located on the Warta and Bug – some of the largest rivers in Poland - are slowly disappearing.
- Loss of wetlands along the Danube River in Romania due to wetlands being converted to agricultural areas.

➢ Invasion by introduced species (i.e. Malta and Bulgaria);

➢ Insufficient level of protection due to important biodiverse areas not being included in protection systems and due to lack of management of currently established protected areas

- This is a threat for plant species with restricted distribution i.e. plants growing on coastal cliffs in Malta;
- In Poland, lack of management expertise and practice is a major threat to wetlands i.e. Luknajno Lake and Karas Lake (Ramsar sites) and national parks i.e. the Biebrza National Park.

b) Indirect threats:

➢ Pollution:

- Acid rain threatens forests in Latvia and Romania;
- Discharges of untreated wastewater to coastal areas (e.g. Latvia);
- Illegal waste dumping (e.g. Malta);

  - Eutrophication exerts a negative pressure on Poland's Ramsar sites; the Swidwie Lake is exposed to slow euthrophication;

    - Excessive use of pesticides in Malta and Romania (particularly in Danube Delta) poses a severe threat especially to fish, bird and marine mammal species.

- Tourism:
  - Increase access and interest in Poland's landscape (especially from the Western tourists) threatens wetland areas i.e. the Great Mazurian Lake District. Tourism also brings noise nuisance and lake pollution as a result of poor sanitary facilities at tourist centres.
  - Uncontrolled tourism in Malta and Latvia;
  - Uncontrolled tourism and camping, burning of juniper and uncontrolled access of off-road motor vehicles threaten Bulgarian and Romanian mountainous ecosystems.
- Trade:
  - Rare and endangered species of plant bulbs from Turkey and Romania (Snowball bulbs) are sold on the market.
- Conflicting use interests:
  - Privatisation of forest areas in Hungary, Slovenia and Romania.
- Lack of implementation and enforcement of nature protection legislation

  - Institutions responsible for biodiversity conservation lack financial and organizational resources to do the job (e.g. Romania and Turkey).
- Low public awareness (e.g. Estonia in Romania).

This section will also be used as a framework against which the qualitative and quantitative benefits presented below will be assessed.

The baseline scenario against which the analysis is carried out is that further erosion and loss of ecosystem and species biodiversity is likely to occur in the Candidate Countries if the Habitats and Wild Birds Directive will not be appropriately implemented.

3 QUALITATIVE ASSESSMENT OF THE BENEFITS

This section provides an overview of the qualitative benefits expected to result from the implementation of the nature protection directives in the Candidate Countries.

The presentation of the benefits is linked where possible to the biodiversity threats presented above and which are likely to be reduced/eliminated if the directives are adequately implemented. This chapter is complemented by Chapter 4 (Quantitative Assessment).

3.1 Approach and Assumptions

As the protected sites under the Wild Birds Directive will be included into the Natura 2000 Network, the assessment will focus on the Habitats Directive. The major assumption behind the analysis is that the candidate countries will implement the nature protection by the date of accession. Article 6 of the Habitats Directive requires the Member States to:

- '*…establish the necessary conservation measures involving, if need be, appropriate management plans specifically designed for the sites or integrated into other development plans, and appropriate statutory, administrative or contractual measures which correspond to the ecological requirements of the natural habitat types in Annex I and the species in Annex II present on the sites'* (paragraph 1).

- '*…take appropriate steps to avoid, in the special areas of conservation, the deterioration of natural habitats and the habitats of species as well as disturbance of the species for which the areas have been designated, in so far as such disturbance could be significant in relation to the objectives of this directive'*.

The list of habitats and species contained in the Annexes of the Habitats Directive does not yet include contributions from the Candidate Countries; however, the species and habitats to be added are expected to be substantial.

3.2 Benefits: qualitative assessment

Under the provision of Article 3 of the directive, the Member States have to establish a coherent network of protected areas, Natura 2000. The Member States are required to '*improve the ecological coherence of Natura 2000 by maintaining, and where appropriate developing, features of the landscape which are of major importance for wild fauna and flora'*. It therefore seems reasonable to assume that the protection of designated SACs identified by the candidate countries under the directive will help protect, in particular, the ecologically sensitive or specifically biodiverse sites. It is important to note at this stage that most endangered species are already subject to protection under several national laws, but that implementation of these laws is sometimes poor. The implementation of the nature protection directives in the Candidate Countries is likely to result in the extension and better protection of important species/habitats. Hence, the potential for benefits from the directive is high.

Threats and Benefits:

The Habitats Directive addresses directly some of the biodiversity threats identified in Section 2. For example, Articles 12 and 13 of the directive prohibit the deliberate capturing and killing of animal species as well as of picking, collecting, cutting, uprooting or destruction of plant species listed in Annex IV (a) and (b). Examples of important sites to be protected in the Candidate Countries and examples of biodiversity threats expected to be reduced/eliminated following implementation include:

- **Bulgaria:** Some widely represented bird species are not protected at all, and there is no prohibition of bird hunting. The wolf *(Canis lupus)*, currently unprotected, will benefit from protection. Expected threats to be avoided as result of implementation are the unsustainable exploitation of terrestrial habitats, poorly planned developments that threaten especially forests and loss of aquatic ecosystems due to water drainage.
- Protection of marine ecosystems will be enhanced in **Cyprus.** The risks from oil pollution will be reduced, aquaculture will be better managed, and urban and tourism developments will have to take into account nature protection considerations;
- **Czech Republic**: more environmentally sustainable agricultural practices (i.e. lower use of pesticides and fertilizers).
- **Estonia**: main benefits can be derived from preventing bog peat harvesting which is a threat especially for the mammal species listed in the Estonian Red Data Book, from reduced drainage of forests and mires, from the prevention of poorly planned transport infrastructure (e.g. road networks). Better-managed tourism and recreation are other likely benefits.
- In **Hungary**, implementation will provide protection to species typical to the central Hungarian Plain and, in particular those that depend upon traditionally managed grasslands and woodlands. Avoided biodiversity threats include excessive hunting, expansion of agriculture and unsustainable forestry activities.
- In **Latvia**, the main benefits could be derived from managing over-extraction of forest resources, protecting newly privately owned forests, prevent hunting, progress towards more sustainable tourism and recreation, measures promoting less intensive farming and the management of the expansion of human settlements and the agricultural areas.
- In **Lithuania**, benefits could arise from reduced exposure of protected areas to agriculture, managed growth of built-up areas and reduced over-exploitation of forest resources. In addition, implementing measures looking at reduce pressure on protected areas from transport, fishery, tourism and recreation will bring benefits. Important conservation areas such as the Curronian Spit and Lagoon, as well as the wetland regions in the south of the country will be protected.

- The key benefits for **Malta**'s biodiversity will be the prevention of bird shooting and trapping and reduced pressure from tourism.
- In **Poland**, benefits will arise from measures to tackle waters and soil pollution, improve forest management, and progress towards more sustainable infrastructure development planning, sustainable exploitation of resources etc.. Biodiversity will gain from measures against illegal species capture and trade, vandalism, and pesticides use in agriculture. The Bialowieska Forest is the main world-refuge for the European bison and its prey (deer, elk, roe-deer); all these populations are in decline. Although the forest is formally declared, under the national law as protected, integrated conservation measures under the directive will contribute to the real preservation of these species.
- Implementation in **Romania** will deliver adequate protection of the Danube Delta. It will also provide protection for sites in the Carpathian Mountains threatened by pollution and land use changes. Other benefits could be derived from less pressure on forest from local and trans-frontier pollution, and from more sustainable forestry.
- In **Slovenia**, the rich biota of the Karst region, currently under threat from human activities, should be protected and the planned highway infrastructure to the coast might be revised to protected designated zones and the continuity of the ecological corridors.
- **In Turkey,** most of the benefits will result from increased protection of the declared protected areas; less habitat destruction through forests and grasslands conversion into arable fields; controlled grazing; prevention of forest fires and illegal logging; and other development activities (e.g. hunting and gathering, road and dam building, mining).

Protecting biodiversity in the Candidate Countries will not only benefit the countries themselves but also Europe and the whole world. The Candidate Countries for example host species that are not longer found throughout Europe:

- The black stork (*Ciconia*), beaver (*Castor fibre*), peregrine falcon (*Falcon peregrinus*) (Latvia);
- The wolf (*Canis lupus*) (Latvia, Bulgaria and Romania);
- The leopard snake (*Elaphe situla*), and the Loggerhead turtle (*Caretta*) (Malta).

Steps in the implementation of the directives

Proper implementation of the directives requires the partners in the Candidate Countries to have sufficient skills and institutional capacity to do their work. This process has started especially through EU-funded and bilateral co-operation projects. Candidate countries have already started to (and will continue to) benefit from know-how transfer projects (under PHARE notably, and bilateral co-operation) in the area of nature protection. These projects draw on the experience of the EU Member States with the implementation of the Habitat Directive and Natura 2000:

- In Estonia, a new GIS-based biodiversity monitoring system has been developed within the framework of a Phare-supported project in 1998;
- In the Czech Republic, a training course for national experts on unified habitat mapping techniques, data storing and assessment methods adapted to the Habitat Directive was put forward as a bilateral Pre-Accession Project proposal in February 2000.
- In the Czech Republic, a PHARE-funded project on the ‘Development of Implementation, Strategies for Approximation of the Environmental *Acquis* was carried out in 1998 and has provided an assessment of the institutional background at national, regional and local level, a detailed approximation plan and a plan for the co-ordination of approximation activities.

Implementation of the nature protection directives is likely to lead to increased awareness of the importance of protecting biodiversity and opens up the opportunity for the adoption of a more integrated approach towards nature protection. Few examples are already available:

- Poland has a well-developed system of nature protection. Under the nature protection requirements set up by the EU, the government intends to buy private grounds currently located inside territory of the National Parks to ensure better protection of these areas. Additionally implementation of the agri-environment programmes in Poland will require farmers to use more environmentally sustainable agricultural practices that will be especially important for fields located in biodiversity valuable territories.

Malta has developed some legislation for nature protection. However, this is not adequately implemented: out of the existing 22 nature reserves only two are properly managed. Malta’s land is under high pressure from development. The implementation of the directive is likely to increased awareness of the importance of habitats and species at national level and European level. Raised awareness will have a positive impact on reducing high pressures from development.

4 QUANTITATIVE ASSESSMENT OF BENEFITS

This chapter, while focusing primarily on the extent of the benefits, notes corresponding qualitative benefits where appropriate.

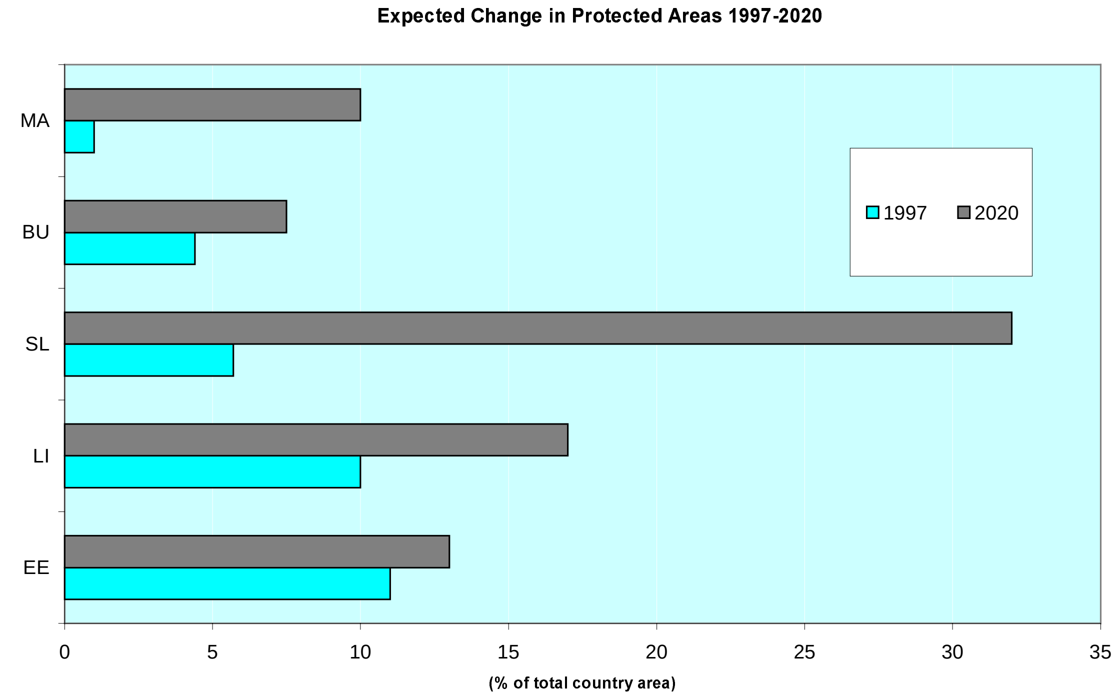
4.1 Environmental benefits

Ecosystem benefits are the main benefits provided by the implementation of the nature protection *acquis*. Through creation of European-wide list of habitats and species of importance, the directive aims to protect species and habitats through a co-ordinated approach requiring the co-operation of countries in areas where species are migratory or habitats span across several territories. The level of benefit that implementation brings will depend to some extent on the effectiveness of this approach and the political will of the countries concerned. There is evidence of improved compliance with the directive as a result of cross-compliance measures taken by the Commission in respect of disbursement of the Structural Funds.

As mentioned in the second section, the main benefit to the candidate countries lays in the increase in protected areas, and their protection from human activity. The bigger the surface protected, the broader the benefits - if the directive requirements for conservation and protection measures are put into place. The total surface of protected areas is expected to increase in the candidate countries. While this is driven mainly by national strategies and plans, the existing and new areas will benefit from the implementation the Habitats directive. As noted in Table E.2 and Fig E.2 some of the Candidate Countries have stated their intention to increase the total area under protection by 2020. Examples of expected increase in protected area’s share of country surface area (expressed as % of country surface area) include:

- **Bulgaria**: the increase in protected area may be by 2.5 percentage points, from 5 % of Bulgaria surface area in 1997 to 7.5% by 2020;
- **Estonia**: 2.3 percentage point increase, from 16% of the country surface area in 1997 to 18.3% by 2020;
- **Lithuania**: expected increase of 8 percentage points, from 11% of country surface area in 1997 to approximately 19% by 2020;
- **Malta**: expected 10 percentage point increase, from 18% of country surface area in 1997 to about 28% by 2020 (where there is a competing demand for land)
- **Slovenia**: 26 percentage point increase, from 6% of country surface area in 1997 to 32% by 2020

Fig. E.2 Expected Change in Protected Areas 1997-2020



Source: World Conservation Monitoring Centre (1998-1999) & Candidate Countries' Experts.

It is important to bear in mind that the foreseen increase in protected areas is relative to the share of each country surface area under protection at present. As of 1997, the total surface of protected areas under national legislation varies:

- 1% of the total country surface in Malta and Turkey,
- 8.4% in Cyprus,
- 10% in Lithuania,
- 12.5% in Latvia,
- 16% in Poland and
- 21.8% in Slovakia.

A large number of these protected areas have been declared in the candidate countries after 1989. However, most do not benefit from real protection. It is not possible at this stage to assess how many of these protected areas are simply 'paper parks' that exist only in official texts and lacking systems of protection measures and management. The implementation of the directive will protect habitats and species under threat to be restored and to benefit from effective protection measures, hence providing a potential improvement of the current biodiversity status. The scale of such a long-term benefit is dependent on the current total area protected by the Candidate Countries, which overall represents 134,080 km2 (including international sites such as Ramsar sites). The total area including IUCN categories I-V amounts to 105,663 km2. Out of this, 10 710 km2 are protected in Slovakia (21.8% of total territory), 12,230 km2 in the Czech Republic (15.8% of total territory) and 29,110 km2 in Poland (16% of total territory). The extent to which protected areas lack sufficient protection measures is a determinant of the scale of medium and long-term benefits.

Candidate countries are likely to seek the protection of **species of Community interest,** defined in Article 1 of the directive as

(i) **Endangered**, except those species whose natural range is marginal in that territory and which are not endangered or vulnerable in the western palearctic region; or

(ii) **Vulnerable**, i.e. believed likely to move into the endangered category in the near future if the causal factors continue operating; or

(iii) **Rare**, i.e. with small populations that are not at present endangered or vulnerable, but are at risk. The species are located within restricted geographical areas or are thinly scattered over a more extensive range;

(iv) **Endemic** and requiring particular attention by reason of the specific nature of their habitat and/or the potential impact of their exploitation on their habitat and/or the potential impact of their exploitation on their conservation status.

Since many countries do officially protect certain of these species but fail to do so in practice, one of the main ecological benefits from implementation will be the conservation of species that are currently disappearing. The benefit will be all the more significant that the number of endemic and threatened species is relatively high in the candidate countries. Overall in the candidate countries for which data was available, there were 722 endemic mammals and 3,402 endemic plants. Importantly, 105 mammals species are threatened, 76 birds species and about 2,110 plant species are endangered.

Plants

Endemic plants: The number of endemic plants is relatively high in the Candidate Countries, accounting for 14% of the total plant species. Examples include:

- Turkey: 31% of total plant species or 3,000 endemic plants
- Bulgaria: 9% of total plant species or 320 endemic plants
- Hungary: 1.8% of total species or 38 endemic plants.

For the sake of comparison, endemic plant species account for only 1.18% of total plant species in Austria, 2.9% in France and 1% in the UK.

Threatened plants: Also, the number of threatened plant species is very high in the candidate countries (e.g. 2,110 species), representing 8.8% of the total plant species in the whole area.

Country examples include 20% in Turkey, 3.8% in Romania and 2.7% in Bulgaria. Given that 14% of these species are endemic, the protection of these species under the Habitat Directive would potentially yield very significant benefits on the scale of the 2,110 endangered species in the whole Candidate country area.

Animals

Endemic animals: Due to the lack of data on endemic mammals, but given the presence of 10 endemic species in Bulgaria representing 12.3% of the total mammal species, it is assumed than the protection of habitats will generate important benefits in biodiversity value in such countries. Endemic bird species are also important in Turkey where they represent 33% of bird species, and Bulgaria where they represent 9% of total bird species.

Threatened/endangered animals: The second major benefit is the future protection of threatened and endangered species. In the candidate countries, these species represent a substantial part of the countries' total species populations. Overall, the proportion of threatened mammal species, in particular, accounts for a significant share of the total mammal population. Examples include:

- 19% in Romania,
- 15% in Turkey,
- 14% in Slovenia
- 12% in Poland
- 7.4% in Lithuania

Slovakia for example has many endangered species (Table E.3); most of these are likely to be protected as a result of the implementation of the directive.

Table E.3. Endangered species in Slovakia

Groups	Number of Species	Endangered (Total number)	Endangered (% of total)
Mammals	85	55	65
Birds	352	114	32
Reptiles	20	20	100
Amphibians	20	20	100
Fishes	78	35	45
Invertebrates	> 28 000	5 021	18

The benefits from the protection of mammal species will be significant as ecosystems in the Candidate Countries host mammals that are currently classified in the existing Annexes II and IV of the directive. If these species are not included in the proposed amendments to the Annexes II and IV, candidate countries will have to strongly justify this omission to the precedent set by the current Annexes. Country examples of minimum expected coverage of Annexes include:

- Malta: 13 Annex II mammals and 19 Annex IV mammals
- Slovenia: 18 Annex II mammals, 28 Annex IV mammals and 17 Annex V mammals.

The number of threatened birds is relatively smaller, but 3% of the total bird species found in the candidate countries is threatened. Examples include:

- Bulgaria: 5% of total bird species
- Hungary: 4.9% of total bird species
- Romania: 4.5% of total bird species
- Turkey: 3.6% of total bird species

Most of these species are expected to be protected is the nature protection directives are implemented. In addition:

- **In Malta,** about 50,000 migratory birds are birds of prey (out of 10 millions passing over the island each year); hence restrictions on hunting practices will result in increased protection of these birds of high ecological importance.
- 48 ornithological sites of EU importance in **Bulgaria**, 34 of which are part of the Corine biotope network. Currently, 34 birds indicated in the directive are not protected in Bulgaria. 6 of the hunted wild species are strictly protected by in the Habitats Directive but are not currently protected in Bulgaria. The implementation of the directives should improve protection.

4.2 Social Benefits

Improved amenity will be a major social benefit not only for people living in the Candidate Countries but also for visitors coming from Europe or other parts of the world. This benefit is enhanced by the fact that cross-border (‘adjoining’) areas of conservation both between EU/candidate countries and the candidate countries themselves is significant: Austria/Czech Republic (Thayatal Nature Reserve and the Podyji National Park), Austria/Hungary (Neuseidlersee Nature Reserve), Czech Republic/Germany (Sachsichse Schweiz National Park), Czech Republic /Poland (Krkonose National Park), Czech Republic /Slovakia (Protected Landscape Area White Carpatians), Italy/Slovenia (Foresta du Tarvisio nature Reserve). These benefits are not quantified in this study.

One of the social benefits is expected from a reduction in hunting practices, which would ensure a safer living environment (i.e. for the Maltese people).

4.3 Economic benefits

Economic exploitation of SACs, according to Article 6 (3) of the Habitats Directive, is still allowed to take place so long as activity does not negatively affect the conservation status of the habitats and species. The directive states that '*Any plan or project not directly connected with or necessary to the management of the site but likely to have a significant effect thereon, either individually or in combination with other plans or projects, shall be subject to appropriate assessment of its implications for the site in view of the site's conservation objectives'*. Certain economic activities (e.g. small scale, traditional and tourism) may benefit from the network of SACs. This will have positive effects on the local economy and would help conciliate local conflicting interests that may arise as result of protection of certain areas.

Recreation and tourism benefits

At present, important economic benefits related to protected areas are missed by the candidate countries mainly due to lack of proper conservation measures and management of these areas. As shown by examples from the Member States, Natura 2000 will preserve the natural attractiveness of the region and so attract more tourists and provide local revenues. Tourism, as long as practiced in sustainability limits, will give an economic spin-off to local economies by creating small-scale opportunities for recreation (bathing, country-skiing, eco-tourism with guided tours), traditional tourism (e.g. local handicraft), linked employment and hence, revenue generation. Examples from the Member States include:

- In the South East region of the UK, the New Forest SAC, part of the Natura 2000 Network, is a complex matrix of habitats, rare and fragmented (including three 'priority' habitats) and supported by a pastoral economy and tourism through high recreational usage (approx. 17 million recreational visits a year). Tourism is the larger employer of local people and generates £100 million per annum but the local negative impacts from recreation on the habitats of the protected area (habitat loss, erosion) are tackled by the LIFE Nature Project by involving local population and raising awareness throughout the area, including the tourism actors. The objective of the project is to secure the objectives of the Natura 2000 network are met.

- In the UK, the Isle of Purbeck contains several Natura 2000 sites with rare species, with 4.3 million visitors per year, tourism accounting for 14% of the county's annual income. The local authorities have set up a strategy involving local populations to reduce the impact of traffic on the ecosystems.

At present, under the harsh current economic conditions, the level of tourism (at least domestic tourism) has decreased significantly over the last ten years in some parts of the CEE region. This phenomenon affects for example the Danube Delta in Romania where tourism has decreased from 59,000 Romanian visitors and 80,000 foreign visitors in 1980 to 13,000 and 5,500 in 1997 respectively. In Turkey it is expected that tourism activities will diversify and expand because of the richness of the ecosystems.

Table E.4 below gives examples of tourism levels (in terms of number of visitors) to some of the protected sites in the Candidate Countries. Annual visitor flows vary across country and type of protected area.

Table E.4: Total Number of Visitors in some Candidate Country Nature Areas

Country	**Site**	**Year**	**Total Number of Visitors per year (in thousands)**
CZ	Sumava National Park (68 520 ha)	1999	1 780
		1998	1 850
		1992	860
EE	Lahemaa National Park (72 910 ha)	1999	82, 771 (6 184 registered)
LV	Teicu nature reserve	Yearly average	1-15
LI	All national parks	Not specified	2 000
	All regional parks	Not specified	3 000
	All nature reserves	Not specified	5
	All protected areas		5 005

Source: partners in the Candidate Countries.

It could be observed that the difference between registered and unregistered visitors in Estonia is striking. Unregistered visitors can indeed threaten the sustainability of the site if they do respect protection rules (i.e. not follow the marked paths, pick up protected plants, camp in non-designated areas, set forest fires). The implementation of key protection measures under the directive should result in more sustainable tourism.

Sustainable and sustained tourism to the sites of the Natura 2000 can provide a job opportunities and revenues (e.g. from entrance fees). However tourism may pose threats to protected areas if the flows of visitors are not regulated. Making sure that tourism will not offsets the benefits gained overall from the implementation, will be a challenge for the national and local governments in the candidate countries.

The benefits from nature protection to local and national economies may act as strong incentives for the candidate countries, many of which struggle with high unemployment levels and tight government budgets. But however attractive the benefits from the tourism industry may look, promoting tourism for the sake of economic gains should not be the main purpose of nature protection. The main role of the protected areas should be the conservation of biodiversity.

Direct Employment benefits

The directive requires the establishment of appropriate management plans for protected areas that fall under the scope of the Habitats Directive. Management plans will include activities such as monitoring, reporting and assessment of the conservation status of habitats and species protected within the Natura 2000 Network, as well as research and scientific work to back up the State's co-ordination task, as well as daily administrative tasks. Taking into account that the number of protected areas is likely to increase in the near future, activities related to nature protection above are likely to generate a limited level of employment. However, this will be a significant benefit for the candidate countries, taking into account the high unemployment rates they are faced with at present.

In some of the candidate countries, protected areas already sustain certain levels of employment on site and in the managing authorities and it is expected that these levels will remain during the implementation phase, with a potential for growth. Country examples of jobs linked to the management, administration, maintenance of protected areas include:

- 795 people are employed by Lithuanian National Parks network
- 150 people are employed by the Estonian National Parks network.

Employment figures vary across countries where some large parks employ more people than the total national park network and some employ a limited number of persons:

- Sumava National Park in the Czech Republic employs 375 people
- Teicu Nature Reserve in Latvia employs 10 staff.

At present, employment levels and opportunities linked to the implementation of the directive at the level of state authorities seem limited:

- In Slovakia implementation still requires the employment of 500 experts. Positive impacts are expected in the form of a strengthening of administrative capacity and ultimately law implementation and enforcement.
- In the Czech Republic, implementation will require employment of 145 new staff in state institutions, including 20 scientific experts per year over the 2001-2003 period and 31 employees at the Czech Environmental Inspection.

4.4 Wider economic benefits

Wider economic benefit expected to result indirectly from nature protection include a range of services provided by forests, wetlands and other ecosystems such as water filtration; the prevention of floods and erosion; and provision of carbon sinks. This benefit will be notably significant in countries where forests account for a large share of the territory: Lithuania (33%), Czech Republic (34%), Bulgaria (36%), Latvia (48%), Estonia (52%) and Slovenia (58%).

Forests are both **key habitats and economic resources** in candidate countries. Currently, forestry in some of the Candidate Countries is largely unsustainable (extensive and uncontrolled logging) and uncompensated by replantation, which has dropped significantly after 1989 (i.e. Romania). If this pattern continues, the forest resources will be depleted in the near future. Forest lost will be a major economic loss. Implementing the Habitats and Wild Birds Directive may stimulate the development and implementation of sustainable forestry strategies. Between 1995-2000 the evolution of the forest growing stock varied across the Candidate Countries. It remained constant for example in the Czech Republic (at 261 m3/ha), Hungary (174 m3/ha), Poland (213 m3/ha) and Slovenia (283 m3/ha), it increased by 2-3% in Slovakia, Lithuania, Turkey and Estonia. The growing stock decreased in Bulgaria and Latvia by 2%. This trend is mirrored by growth in wooded area, which increased by a similar scale or remained constant while the intensity of felling followed the same downward path (-18% in Latvia, -6% in Lithuania, -4% in Slovakia, -3% in Poland and Hungary while felling intensity remained constant in other candidate countries. It is likely that implementing the directive will support the current trend and improve the sustainability of forestry further.

The training requirement for staff and national experts in the field of nature protection monitoring techniques and management has led to several co-operation projects to ensure nature protection specific ‘know-how transfer’ takes place. Increased scientific and management skills can be seen as a wider economic benefit as it increase the scientific capacity of national staff and can lead to economic benefits in the future for the country (skills can be transferred further to other countries). Wider social benefits in the form of institutional strengthening that can in the future lead to economic benefits (though better implementation).

Overall the benefits presented above are summarised in Table E.5.

Table E.5: Areas of Potential Benefits from the implementation of the Habitats Directive

ENVIRONMENTAL (Ecosystems, species, land use)	ECONOMIC (Employment, tourism)	SOCIO-CULTURAL (Health, recreation, amenity)
• Enhanced protection of protected areas • Sustainable harvesting of timber and non-timber products • Restricted fishing & hunting • Gene harvesting • Controlled grazing • Wildlife habitats for native & migratory species	• Generation of revenues from tourism (i.e. access charges.	• Employment (job creation)
• Improvement of environmental data and database • Sustainable agriculture • Protection of migratory birds across borders • Maintenance of ecosystems functions (rivers, mountains) • Gain in Biodiversity value	• Growing opportunities for eco-tourism • Additional EU-funding (Life Programme for management, etc…) • Stimulation of local economic development	• Recreation • Amenity value • Increased public environmental awareness • Public participation in decision-making[2] • Education and research promotion • Networking

[2] Under the Habitats Directive, the public must be consulted in case a development plan is likely to have a significant impact upon a Special Area of Conservation (SAC) or in case the re-introduction of native species is decided. The Directive also requires MS to promote education and general information on species protection and conservation.

5 CONCLUSIONS

The extent to which these benefits will take place depends on the inclusion of species and habitats proposed by the Candidate Countries in the Directive's Annexes I, II and IV (a) and (b). Therefore it is difficult at this stage to assess further the quantitative benefits related to the species to benefit from protection under the Habitats Directive. Some countries have already asked for the addition of certain species to the Annexes of the Habitats and Wild Birds Directive. For example Lithuania has requested the addition to the Annex I of the Wild Birds Directive of the several species considered rare or in danger of extinction in Lithuania and the Baltic Sea region: Steller's eider *(Polysticta stelleri),* the Dunlin *(Calidris alpina Schinzii)* and the Little gull (*Larus minutus*).

Requests for the exemption of certain species from the Annexes of the nature protection directives have been also submitted by certain Candidate Countries. Lithuania for example has asked for exemption of wolves *(Canis lupus)* and beavers *(Castor fiber)* from the Annex II (species of Community interest) and IV (strictly protected species) of the Habitats Directive. If this request is accepted by the European Commission, wolves and beavers will continue to be hunted in Lithuania (while under protection in the EU countries). Estonia is also likely to request exemption of certain species (not clear which species will make the subject of these request).

The above-mentioned benefits – increase in surface area and species protected – should not be seen solely as a unilateral gain. Protecting biodiversity in the candidate countries will bring biodiversity benefits at European and global scales. Hence the results are presented at the whole Candidate country region scale, supported by some country-specific examples.

It is important to bear in mind that the implementation of the Habitats Directive may imply some negative impacts on nature protection in the candidate countries. These potential caveats include:

- Article 4 (2), Paragraph 2 of the Habitats Directive allows for more flexibility in the designation of protected area in the circumstances where habitats protected exceeds more than 5% of the country surface area. As shown in Table E1, most of the protected areas in the Candidate Countries are already exceeding 5% of the country surface area; as a result of implementing the directive, strict nature conservation policies in some Candidate Countries may be actually 'loosened';

- The conditions aimed at ensuring a coherent European ecological network are not clear;

- Biodiversity conservation can be restricted in case of development projects of overriding public interest; this may proof problematic in the candidate countries where economic development is a first class priority.

The potential benefits from implementing the Habitat and Wild Birds Directive in the candidate countries are significant, providing the full implementation of the directive, and the coherence of the Natura 2000 Network to be established. As demonstrated in Sections 1 and 2, the main benefits are the environmental benefits in terms of ecosystem and species protection, or ‘biodiversity benefits’ altogether. Social and economic benefits are less significant and will greatly depend on the level of implementation once the Network is established.

The biodiversity benefits are mainly those resulting from the effective protection of endangered species and fragile ecosystems. To the EU as a whole, this implies high benefits, given the richness of biodiversity in the candidate countries, both in terms of highly valuable habitats (forests, mountains, wetlands) and mammals, birds and plants.

Over a long-term time period, and at institutional level, the implementation of the directive will provide great opportunities for know-how transfer (habitat and species inventory, monitoring of the sites, management) and institutional strengthening which are key elements for an effective nature protection policy. At a political level, the use of stakeholder consultations, public reporting, and a more integrated approach to regional development including sustainable agriculture, sustainable tourism and land-use will in the future lead significant benefits to both the environment and the populations.

THE BENEFITS OF COMPLIANCE WITH THE ENVIRONMENTAL ACQUIS FOR THE CANDIDATE COUNTRIES

PART F: SOCIO-ECONOMIC ASSESSMENT: EMPLOYMENT ANALYSIS

PART F: SOCIO-ECONOMIC ASSESSMENT: EMPLOYMENT ANALYSIS

Contents

PART F: SOCIO-ECONOMIC ASSESSMENT: EMPLOYMENT ANALYSIS

1.0 INTRODUCTION

This Part F explores the socio-economic benefits that are likely to arise from the full implementation of the EU acquis communautaire in the candidate countries. The quantitative analysis will focus only on the employment benefits. There is, however, a large range of potential socio-economic benefits likely to arise from the implementation of the environmental chapter of the *acquis Communautaire*. These include:

- Support for **employment** in the eco-industries through increased investment and more developed infrastructure (with associated higher operation and maintenance activities). Sectors such as construction and capital good providers will also benefit as the demand from eco-industry activities necessarily requires inputs from these sectors;
- Improvements in the **eco-efficiencies** of industry as new processes are put in place and existing activities, where relevant, made more sustainable – this will lead to a reduction in the **resource intensity** of production processes, and one could expect sector and national improvements in energy and water use per unit GDP or per unit value added. One could also expect a reduction in the amount of use of primary raw materials in the production process as reuse, recycling practices and pricing policies take effect (recall discussion on this in Part C - Waste). It is clear from existing statistics that the eco-efficiencies of many industries in the candidate countries lag by far those in many European Union Member States[1];
- The improvements in eco-efficiencies will undoubtedly help the **competitiveness** of many of the industries in the candidate countries, and support them in the process of entry to the competitive European internal market. This will not only support the economy, but also help address employment, and national balance of payments issues.
- Improvements in the **pollution intensities** of the production processes – one could expect a reduction in the amount of pollutants (e.g. CO2, NOx, SOx, dangerous substance discharges to water, waste arisings) associated with a unit of GDP or value added of the economy as a whole and certain sectors in particular. As with resource intensities, the pollution intensities of production are often higher in the candidate countries than in most of the EU Member States. This will lead to social benefits (see Part B on air) given health benefits. It is less clear whether the energy use, natural **resource use and pollution levels per capita** will rise or fall. It is clear that the intensity for a given consumption would drop, but this will be partly (if not wholly) offset by changes in consumption patterns.
- In addition, there are clearly going to be some positive **enterprise culture** developments that can lead to some economic benefits and avoided costs. This

[1] See EEA (2001): *Environmental Signals 2001*, European Environment Agency Regular Indicator Report. Environmental Assessment Report No 8.

includes for example the likely impact of implementing the Seveso II (ComaH) Directive, as this should help reduce the likeliness of accidents and their costs (see Part B)

The above is but a short list of the type of socio-economic benefits likely to accrue (in part) through the proper implementation of the environmental acquis. Importantly the benefits will also depend on the development of the economy, consumer preferences, and national programmes and strategies.

The study team investigated the possibilities of developing robust estimates for several of the above listed benefits. The issue most amenable to a quantitative assessment was that of the impact on employment. This Part F therefore focuses on the level of employment that is likely to arise from the expected environmental expenditures required to implement the acquis – with a view of obtaining an "order of magnitude" estimate that allows the importance of the issue to be highlighted. Additional work by the European Commission[2] is currently looking at a more elaborated analysis.

The study team concluded that it would not be possible to derive a quantitative analysis of the impacts on competitiveness, on the eco-efficiencies of productions and the economies, or indeed on the pollution intensive of consumption, given, in particular, the difficulties in predicting likely economic development paths, industry restructuring plans, and consumer spending patterns. This is a non-trivial exercise and a rough estimate would undermine the credibility of the more robust answers presented in Parts B, C and D of this report. Furthermore, the changes cannot be uniquely attributed to implementing the environmental acquis, and therefore tying in the benefits to the environmental acquis could open such analysis to criticism, again potentially undermining the value of other parts of the study.

However, while no full analysis of the broad range of socio-economic benefits has been carried out, where robust insights were possible, these were presented in the relevant parts of the report (for example a look at the reduction of primary materials use is presented in Part D on waste).

1.1 Context and Rationale for the Analysis

This section summarises the assessment of the number of jobs that could be supported by the investment made in implementing the acquis in the candidate countries. This analysis aims to develop an order of magnitude estimate. The quantitative analysis should be taken only as an indicative estimate at this time, not least because the nature of implementation pathways and the choice of detailed policy options (which will determine the labour intensity of activity) are not known.

[2] The study - *Analysis of the EU Eco-Industries, their Employment and Export Potential* – is likely to be available towards the end of 2001.

The purpose of calculating the potential employment effects is to demonstrate that there are strong inter-actions between the implementation of the environmental acquis and the economy. These relationships are discussed in Part A. One of the most important, but by no means only, economic effects is the impact that the investment programmes will have on the labour market. A significant numbers of jobs could be supported either through new investments or through the operation and maintenance of plant and infrastructures.

This analysis contributes to the wider discussion about the integration of environmental protection with economic development. It does this not only by looking at the potential jobs that could be supported by environmental expenditure, but also through highlighting the importance of the choice of implementation paths for directives in supporting jobs and hence in contributing to long term sustainability of future development paths in the candidate countries. At a more modest level the analysis helps address a common misunderstanding – namely that investment in the environment will cost jobs. It is clear from work in the EU[3] that environmental expenditure supports a significant number of jobs. The same is clearly the case for the candidate countries - whether through increased employment in the construction sector given new build of landfill sites, water supply, sewage networks and waste water treatment plant, or employment in environmental services – e.g waste collection, separation and recycling.

1.2 Focus of the Analysis

Focus on eco-industries: Eco-industries (also called environmental industries) are constituted of firms that provide goods and services used for environmental protection. The most significant environmental industries correspond to the main environmental sectors: air pollution control, water supply and waste water treatment, waste management, and the combination thereof in the industrial pollution chapter of the environmental *acquis*.

The employment associated with these industries can be calculated on the basis of level of environmental expenditure required to implement the acquis for these sectors. This is a reasonable guide to the future level of demand for environmental services, and demand for new environmental infrastructure (and associated inputs of capital goods, construction etc). This in turn will allow an assessment of the level of employment. Of course a more detailed analysis would allow for the effects of imports and exports in meeting demand, but such an analysis is beyond the scope of this study.

[3] For example as demonstrated in the context of environmental expenditure in the EU: the 1997 DGENV/Eurostat report: *Data Collection on EU Eco-Industries, European Commission, 1994*. A further European Commission report - *Study On Investment and Employment Related to EU Policy on Air, Water and Waste* - focused on ten specific Directives, complementing the 1997 report. While these two reports have focused on the EU, a current study - *Analysis of the EU Eco-Industries, their Employment and Export Potential* – will not only develop an update of the 1997 report, but also extend the analysis to the Candidate Countries. This last report should be available at the end of 2001.

The estimates given are based on a number of assumptions (see below), including the period required for the implementation for all Directives in all candidate countries, the share of investment that goes to labour, the share of expenditure that stays in the Candidate country, the relationship between capital expenditure and the costs of operating and maintaining environmental infrastructures and the costs of providing environmental services.

Due to the uncertainty associated with each of these assumptions, the estimates for the number of jobs supported can only be given as an order of magnitude. No assessment is carried out of how many of these jobs will be additional (i.e. newly created jobs), or to what extent the environment related jobs will displace non-environmental jobs. Such an assessment is complex and beyond the scope of the existing study. The results need to be seen in this context to avoid misinterpretation of the meaning of the results (see discussion further below on interpretation of results).

No focus on impacts on other industries: In principle there can be both positive and negative impacts of new environmental regulation on other industries. These can be positive, where the production efficiency is increased and where pollution costs are reduced with subsequent improvement in profitability of the enterprise and hence possible scope for increased employment. The negative impacts concern the argued additional burdens on industry leading to reductions in profitability, reduced employment, and in the extreme case, the potential closure of plant.

Possible negative impacts: When environmental legislation is passed or en route, there is always a lengthy discussion as to the competitiveness impacts and the likely adverse effects on employment. This argument is understandable given concerns from industry, but often exaggerates the true threats to competitiveness and employment. There is far less evidence of averse employment effects from regulation than the critics would suggest, and far lower competitiveness impacts arising from environmental concerns. In general wage costs, labour taxes, corporate taxes and inherent process/products comparative advantages decide competitiveness and not environmental measures.

The study team does not feel that an analysis of the adverse employment impacts of industry (by looking at the additional burden due to environmental measures), would lead to any important new conclusions. Furthermore, such an exercise is non-trivial and potentially misleading, as assertions of industry closure due to environmental legislation might in real fact be due to competitiveness of the market and inability of old enterprises to compete.

It is clear, however, that certain polluting industries will close down over a period of time (e.g. smaller refineries in southern Poland) and that this is accelerated by tightening environmental legislation. It is not correct, however, to say that these will be closed due to environmental concerns, given that inefficient refineries have trouble selling products at competitive prices. In addition, where there are real employment concerns, these are being addressed in the accession negotiations, and where local employment concerns are truly important, then additional time might be given for non-compliant plant to become compliant, or for plant closure.

As well as these direct impacts, there may be indirect impacts. Money spent on environmental protection cannot be spent on consumer goods, for example. The result may be that there will be a lower demand for consumer goods and reduced employment in these seemingly unrelated industries.

Possible positive impacts: The arguments suggesting possible increased employment in industries is well known – the regulatory and economic signals will help improve the efficiencies of production processes (leading to higher profitability and hence greater potential to recruit) and the pressures should also lead to improved product design encouraging more energy efficient and less polluting products to be bought, with subsequent benefits for employment in these sectors. However, estimating the efficiency improvements due to the signals from the process of implementing environmental acquis is a non-trivial task and the task of apportioning the benefits between those due to the environmental acquis and those due to normal market pressures will be extremely difficult (possibly impossible) and open to criticism of trying to fix the numbers, with due negative impacts on the credibility of other estimates in the study that are truly robust.

Consequently, the analysis focuses here on the employment impacts on the eco-industries, and the other areas of probably positive influence are only described qualitatively above.

1.3 Introduction to the Methodology

To arrive at an employment analysis, this study has adopted a top-down assessment, based on estimates of required expenditure to implement the environmental acquis. In short, jobs are created or supported by that share of expenditure that relates to labour inputs. Details on the method are presented in the Annex. The key points, however, are:

- The level of required expenditure gives an indication of the scale of the industry being supported/created;
- A share of this expenditure supports jobs in the provision of environmental services, in the operation and maintenance of environmental infrastructures, in the construction / development of these infrastructures, and in the provision of environmental goods;
- With additional knowledge of the share of labour in the costs of providing environmental goods and services (including operation and maintenance), it is possible to assess what amount of money is allocated to wages.
- Finally, when the total sum allocated to wages is combined with the average wage costs, it is possible to arrive at an estimate of the total number of jobs supported.

For the analysis of the environmental related employment in the candidate countries, expenditure is given by the level of expenditure required to implement the acquis. This will therefore relate to expenditure over a longer time period (see method in Annex), and hence provide a value of jobs supported over a number of years, given in units of “total job years”. Clearly not all investments will be carried out in one year, and operation and maintenance is an ongoing activity, therefore the “total job years” is converted into “jobs per year” to arrive at a more intuitive and easily understandable value. For simplicity and to avoid confusion, the “jobs per year” can also be called “jobs at any given time”. In other words, 20 “job-years” is equivalent, over a 20-year period, to 1 “job per year”, or 1 “job at any given time” over the period.

1.4 Structure of Part F

This introduction is followed by the main results section (Section 2), and by Section 3, which presents an interpretation of the results. The detailed method is presented in the Annex; this is important for a full appreciation of not only how the results were derived, but also helps in the interpretation of the results.

2.0 RESULTS

Environment expenditure associated with fully implementing the acquis is estimated to lead to around an average of 1.8m jobs at any given time across the candidate countries. Of these, around 0.5 million relate to capital expenditure. These values clearly present a strong message: a large number of jobs can be supported by environmental investments in the candidate countries.

The total number of job-years that could be supported by environmental expenditure amounts to 37 million for whole the period up to 2020, of which 9 million are related to capital expenditure[4]. The 37 million combines jobs that are there for the 20 years period (operation and maintenance of a compliant plant on stream in 2000), and jobs that are there for shorter periods (e.g. 2 years during construction of a plant).

It is clear that the profile of employment that is supported will grow for the operation and maintenance and services related activities up to the full implementation date of 2010, and thereafter stabilise (though with potential continued growth if emphasis moves away from landfill towards recycling and composting – see Part D Waste).

For employment related to capital expenditure - there will be a strong growth in the first ten years (depending a little on the investment planning approach and prioritisation of different sectors), though with a significant fall subsequently to levels of a more mature sector. The extent of the reduction depends on the economic growth, consumer habits, and directive implementation strategies. The latter point is important as Landfill Directive requirement for reducing the biodegradable waste component sent to landfill can be implemented through recycling/composting or through incineration, or a mixture (see Part D Waste for discussion) – where incineration is the choice, there is likely to be more capital expenditure on incinerators over the period 2010 to 2020.

The estimates have, however, to be seen in context. The basic assumption driving the analysis is that with lower wages, more labour will be used as a factor of production. This clearly will be the case, but only to some extent. In some cases there are technical limitations to how many people can be employed – to put it simply, no matter how cheap labour is, there is only one driver of a waste truck. **The values should therefore be seen as an overestimate**. However, using EU wage rates would have led to an underestimate of employment, as clearly activities will be more labour intense with the lower wage rates in a number of candidate countries. Furthermore, it is clear that some of the expenditure will be on imported goods, which will lead to fewer jobs being supported in the candidate countries. This is not thought, however, to lead to significant changes in the employment figures, given that most of the employment is associated with environmental services and basic construction activities and capital goods that will be provided within the candidate countries.

[4] Recall that 20 job-years are equivalent to 1 job/year over the 20-year period.

Country specific results: The greatest number of jobs supported overall by the eco-industries given would be in Bulgaria: 12.4 million job-years, or approximately 600,000 jobs at any given time – this is driven by the high costs of complying with the acquis, and the low wage rates in Bulgaria (106 EUR/month). Comparing this with the figures of a total workforce of 4,000,000, and unemployment of 640,000 (see Table F.A3 in the annex) it seems clearly unlikely that new investment in the eco-industries would basically result in full employment. Nevertheless, even assuming that the estimate would need to be reduced significantly given the technical limits to capital substitution, and even assuming that there would be some substitution of employment from other sectors (whose labour intensity is likely to be less), the conclusion remains clear: environmental expenditure related to implementing the acquis can help support a large number of jobs.

The next greatest number of jobs supported by eco-industries would be in Poland: 7.5 million job-years or an average of 379,000 jobs at any given time during the 20-year period. This level of employment seams more feasible as it would represent about 2.5% of the total employment and represents 1.8% of the unemployment rate.

Total operating expenditure (OPEX) related employment accounts for approximately ¾ of the total estimated employment, or approximately 25 million job-years. The highest values are in Bulgaria, 9.3 million job-years (33.8% of the total OPEX-related job-years), Poland 5.4 million job-years (19.7%) and Romania 5.2 million job-years (19%). Total capital expenditure (CAPEX) related employment is 9.2 million job-years.

Key sectors providing support for employment: In terms of the relative importance of the main sectors of the environmental industry, it is not surprising that the greatest employment effect is driven by the development of the waste management sector, given the labour intensity of waste collection and disposal. See Table F.2 for details.

While environmental investments should not be driven by employment concerns, a reflection on the employment and local economic development benefits of environmental investments in priority setting and investment decisions could be valuable. It also helps to remind policy makers of the wider relation between environmental improvement and economic development.

Table F.1: Total employment related to CAPEX & OPEX in the ACs

	EMPLOYMENT: JOB-YEARS (thousands)			EMPLOYMENT: JOBS/YEAR (thousands)		
	OPEX	CAPEX	TOTAL	OPEX	CAPEX	TOTAL
Bulgaria	9,352	3,079	12,431	468	154	622
Cyprus	35	26	61	2	1	3
Czech Republic	2, 307	837	3,145	115	42	157
Estonia	830	216	1,046	41	11	52
Hungary	1,364	653	2,018	68	33	101
Latvia	547	247	794	27	12	40
Lithuania	553	238	791	28	12	40
Malta	:	:	:	:	:	:
Poland	5,442	2,133	7,575	272	107	379
Romania	5,280	1,467	6,746	264*	73*	337*
Slovakia	1,618	533	2,151	81	27	108
Slovenia	312	94	406	16	5	20
Turkey	:	:	:	:	:	:
TOTAL	**25,333**	**9,523**	**37,164**	**1,382**	**477**	**1,859**

Table F2: Total Employment (Job-Years) By Eco-Industry in the candidate countries

	OPEX-related job-years (thousand)					*CAPEX-related job-years (thousand)*					TOTAL JOBS
	Air	Waste	Water	Industry Pollution Control	Total	Air	Waste	Water	Industry Pollution Control	Total	
Bulgaria	704	4,742	322	3,583	9,352	566	641	564	1,308	3,079	12,431
Cyprus	1	15	11	8	35	1	2	19	4	26	61
Czech Republic	179	724	60	1,344	2,307	144	98	105	491	837	3,145
Estonia	47	539	11	233	830	38	73	19	87	216	1,046
Hungary	214	326	99	726	1,364	172	44	173	265	653	2,018
Latvia	87	345	64	51	547	70	47	112	19	247	794
Lithuania	151	332	32	37	553	122	45	57	15	238	791
Malta	:	:	:	:	:	:	:	:	:	:	:
Poland	484	2,233	323	2,402	5,442	389	302	565	877	2,133	7,575
Romania	464	3,934	174	709	5,280	373	531	304	259	1,467	6,746
Slovakia	140	713	33	733	1,618	112	13	57	267	533	2,151
Slovenia	16	255	22	18	312	13	35	39	8	94	406
Turkey	:	:	:	:	:	:	:	:	:	:	:
TOTAL	**2,488**	**14,159**	**1,151**	**9,844**	**27,641**	**1,999**	**1,829**	**2,013**	**3,599**	**9,523**	**37,164**

3.0 INTERPRETATION OF RESULTS

This analysis was not directed to establishing a statistically defensible analysis with specified confidence bounds, rather it was aimed at underlining the message that environmental investments can support a significant number of jobs, and that this benefit should not be ignored in priority setting and investment decisions. Furthermore, the aim was to underline the importance of assessing employment benefits such that policies can take appropriate account of the inter-relations between environment and employment.

This analysis has only looked at the gross job creation, which, while important in employment market analysis for eco-industries, ignores the fact that the expenditure on environmental matters will imply a reduced expenditure in other areas, and consequently a reduced level of employment. It is clear that the net job creation would be significantly lower than the gross values noted above, and there may well be no net job creation. The analysis here is but a first cut analysis to highlight the importance of this issue.

Further analysis should allow revision of the top down model for estimates (including the testing of assumptions), and to complement this with bottom-up approaches (e.g. using surveys of key environmental industries), and some selective case examples of where employment benefits accrue. An analysis of the trade-offs could also valuably be carried out – which would highlight the "winners and losers" through choices of investment expenditure. All countries are going through structural changes and knowledge of who would gain and who would lose could support the development of appropriate policies.

Having stated all the assumptions and caveats, the key message still holds: the implementation of the acquis communautaire in the candidate countries will lead to the development of a significant eco-industries sector which will support significant number of jobs. And while there will be winners and losers within the employment market of the economy overall, it is clear that the employment sub-market related to eco-industries and supporting industries will be a winner in the accession process.

PART F

ANNEX

ANNEX 1: METHOD OF APPROACH

The method adopted is a top-down assessment, based on estimates of required expenditure to implement the environmental acquis. In sum, jobs are created or supported by that share of expenditure that relates to labour inputs. The steps of the analysis are:

1. Assess the level of expenditure needed to comply with the acquis – in terms of both capital expenditure (e.g. on new investments) and operating expenditure (for new investments and for existing infrastructure);
2. Assess the share of operating expenditure (OPEX) that goes to employment – using "engineering analysis" (See table below);
3. Assess the destination of capital expenditure (CAPEX) - to which intermediate inputs: construction, capital goods, energy, services etc.;
4. For the capital expenditure supported investment in the intermediate goods, assess the share that goes to labour – using "engineering analysis";
5. Take the labour related share of CAPEX and OPEX, and average labour costs in the candidate countries and calculate the number of jobs years that would be supported – simply divide expenditure on labour by the wage costs;
6. Assess over what time the expenditure would be spread and calculate average annual number of jobs supported.

This is the same method as was used in the 1997 DGENV/Eurostat report: *Data Collection on EU Eco-Industries*, with the exception of the last step as the DGENV/Eurostat report assessed employment for a single year.

Time period: For this analysis we have assumed that the full implementation period is 2010 (core estimate) and 2020 for a sensitivity estimate (not unlikely for many countries given the demands of the Urban Waste Water Treatment Directive and the Landfill Directive targets which go beyond 2010). While these are the dates for full implementation, it is clear that there will be jobs supported by the operation and maintenance of environmental infrastructures over the whole period to 2020 and beyond. In the period up to the full implementation of the acquis the share of capital expenditure will be higher, and in the period after full implementation the share of operating expenditure will increase (as fewer new facilities need to be built, but all facilities need to be operated and maintained, and environmental services, such as waste collection, continue).

Data: Data for the candidate countries was available primarily for the capital expenditure needed for implementing the acquis. To arrive at a value for the operating expenditure we have assumed that the ratio of capital and operating expenditure is not dissimilar from that in the EU. This is obviously an important assumption, and hence underlines the fact that the result of this analysis will be an order of magnitude estimate.

The ratio of capital to operating expenditure will clearly not be the same in the candidate countries as for the EU during the phase of intense capital investment in new infrastructure in the candidate countries (i.e. up to 2010) – hence characterised as a growing and not yet mature industry.

However, in the period 2010 to 2020 the ratio of capital to operating expenditure in the candidate countries will change, and take the form more of the "standard" ratios of a more mature, though still growing industry. Here it becomes more comparable to the EU.

Hence for this analysis we take the period of 2020 as a whole as the time over which the full capital and operating expenditure will take place and for which the EU ratios of capital/operating costs can arguably be applied for the candidate countries. This is important, as it is the operating cost element that provides the greatest share of jobs, and were we to assume that the ratio of capital to operating expenditure in the candidate country environmental industry high growth phase up to 2010 is the same as in the EU, then the estimates would be a significant over-estimate.

We have therefore calculated the total job years supported on the grounds of capital expenditure required for full implementation and associated operating and maintenance costs, and for the estimate of the average numbers of jobs supported in the average year, we have taken the 20 year period.

The study team feel that in this way we arrive at a more realistic (and potentially more conservative) estimate for employment than the one we would have obtained had we focused only on the full implementation phase (see interpretation of results for further discussion on the implications of the assumptions).

To reiterate, the aim of this analysis is to highlight the importance of environmental investments in the development of the labour market related to eco-industries. An order of magnitude estimate will help clarify the level of importance. But subsequent work will be required to obtain figures that are more fine tuned with the actual levels of employment likely from environmental expenditure – such work is currently being carried out by DGENV and this work here will be available as a preliminary input to this exercise.

Expenditure Values: Estimates for the capital expenditure (CAPEX) associated with the implementation of investment-heavy Directives were derived from a compilation of World Bank, Phare (DISAE) and candidate country estimates of compliance costs in the candidate countries – as presented in the annex.

CAPEX values were used to estimate the operating expenditure (OPEX) by using the assumption that the EU-average ratio[5] between CAPEX and OPEX for eco-industries is the same for the candidate countries. This leads to required expenditure levels of around twice that of the investment costs only estimate (see Table F.A4, in the annex).

[5] European Commission. 1997. *An Estimate of Eco-Industries in the European Union 1994.*

The ratio of CAPEX and OPEX in the EU reflects a more or less mature (but still growing) infrastructure (certainly for waste and water, and increasingly so for air). In this case, the expenditure is essentially driven by the need to renew, or replace the loss of, the existing capital stock. While the candidate countries are in the situation of now needing to embark on significant increases in investments (with some exceptions), the timescale of our analysis – 20 years – means that the assumption is acceptable, at least in the attempt to get an order of magnitude estimate. In practice, even with a 20 year period, the true share of CAPEX is likely to be a higher (and OPEX lower) than estimated, and the actual employment levels lower than those estimated - though this is due not only to the issue of the maturity of the industry, but also due to differences in labour costs (See section on Jobs created by OPEX below).

Table F.A4 present current estimates of compliance costs (OPEX and CAPEX) in the candidate countries by environmental sector. In Table F.A2, CAPEX is presented in more detail, per each investment-heavy Directive. Compliance cost estimates could be taken as an indicator of the importance that eco-industries may potentially have in the next 20 years in the candidate countries as a job generator. OPEX is highest for the waste industry (55,9 MEUR), which is not surprising taking into account that waste management is a labour intensive sector.

CAPEX is estimated to be greatest for air pollution and industrial pollution control, especially in heavily industrialised countries. For example the costs of compliance with the IPPC Directive appears to be highest in Bulgaria (3,261 MEUR), Czech Republic (3,725 MEUR) and Poland (6,927 MEUR). Water related eco-industries (i.e. urban wastewater treatment and drinking water supply) are expected to be the next most expensive industry requiring a total investment of 15,833 MEUR. High costs related to compliance with the Urban Wastewater Directives are expected in Poland (6,524 MEUR) where only 45% of population is connected to a sewerage system and wastewater treatment plants and Bulgaria (2,056 MEUR) where the connection rates are 72% for sewerage systems and 63% for wastewater treatment.

Jobs created by OPEX: The proportion of OPEX spent on remuneration or "compensation to employees" (the official term used by statistical offices) is assumed to be the same for the candidate countries as that in the EU. This proportion varies across sectors depending on how labour intensive the sector is – with a greater share going to labour in the waste sector than in the air sector. The proportion of OPEX spent on wages is divided by the average wage in the particular AC. This gives the number of job-years created for the OPEX. The number of jobs created per year was calculated by dividing the number of job-years by 20 (as discussed above).

The engineering analysis: share of remuneration or compensation to employees is given in Table F.A1.

Jobs created by CAPEX: The jobs created by CAPEX have been calculated in a similar manner. Initially, CAPEX has been broken into three categories: construction, goods and services. It is assumed that the proportion of these three categories is the same in the candidate countries as that in the EU for CAPEX (Table F.A2). It is also assumed that all CAPEX takes place within the particular CC (trade flows have not been taken into account).

Table F.A1: Engineering analysis: OPEX

	OPEX										
	Compensation to employees	Agriculture	Energy	Intermediate Goods	Capital Goods	Consumer goods	Construction	Transport & Communications	Private services	Public services	Total
Air Pollution Control	15%		35%	45%						5%	100%
Waste Water Treatment	40%		20%	20%	10%				10%		100%
Waste Management	60%		10%	10%	10%				10%		100%
Industrial Pollution control*	20%		30%	50%							100%

Note: "Other" based on EU average

Source: DGENV/EUROSTAT: Data Collection on EU Eco--industries

Table F.A2: Engineering analysis: CAPEX

	Share of intermediate inputs					Share of CAPEX that goes to employment			
	Direct Compensation to employees	Capital Goods	Construction	Private services	Total	Capital goods	construction	services	Total
Air Pollution Control	0	85%	15%		100%	31.5%	4.8%	0.0%	36.3%
Waste Water Treatment	0	20%	70%	10%	100%	7.4%	22.4%	3.0%	32.8%
Waste Management	0	60%	30%	10%	100%	22.2%	9.6%	3.0%	34.8%
Industrial Pollution control*	0	42%	51%	7%	100%	15.5%	16.3%	2.1%	33.9%
Comp to employees ratio		32%	37%	30%					

Note: "Other" Based on EU Average

TableF.A3: Population and Employment in the ACs

COUNTRY	POPULATION (mil.) (1999)	ECONOMIC ACTIVITY RATE (as % of labour force) (1998)	EMPLOYED PERSONS (in 1000s) (1998)	UNEMPLOYMENT RATE (% of labour force)	MONTHLY GROSS NOMINAL WAGES (EURO) (1998)
Bulgaria	8.211	50.4	3,030.0	16	106
Cyprus	0.665	61.5	287.5		1,305
Czech Republic	10.285	61	4,873.9	6.5	322
Estonia	1.442	60.5	640.2	9.9	262
Hungary	10.068	51.7	3,812.0	7.8	282
Latvia	2.432	58.8	1,015.0	13.8	201
Lithuania	3.7	61.7	1,647.5	13.3	222
Malta	0.387	48.3	138,206.0	5.1	:
Poland	38.654	57.4	15,177.0	10.6	335
Romania	22.458	63.3	8,813.0	6.3	132
Slovakia	5.395	59.9	2,132.1	12.5	253
Slovenia	1.986	59.4	898.0	7.9	850
Turkey	64.33	51.3	:	6.4	565

Source: Eurostat, 2000

Table F.A4 Estimates of Compliance Costs (CAPEX & OPEX) by Environmental Sector

	Compliance Costs by Environmental Sectors (MEUR)														
	Air			**Water**			**Waste**			**Industrial Pollution Control**			**Total**		
	CAPEX	OPEX	TOTAL	CAPEX	***OPEX***	***TOTAL***	CAPEX	OPEX	TOTAL	CAPEX	OPEX	TOTAL	CAPEX	OPEX	TOTAL
Bulgaria	1,980	*2,233*	4,213	2,056	*2,044*	4,100	2,477	*10,025*	12,502	4,888	*6,992*	11,880	11,401	*21,295*	32,696
Cyprus	47	*53*	100	846	*841*	1,686	99	*401*	500	169	*190*	359	1,160	*1,485*	2,646
CR	1,535	*1,731*	3,266	1,164	*1,157*	2,321	1,152	*4,662*	5,814	5,583	*7,987*	13,570	9,434	*15,538*	24,972
Estonia	328	*370*	698	168	*167*	335	698	*2,825*	3,523	801	*1,125*	1,926	1,995	*4,487*	6,482
Hungary	1,601	*1,806*	3,407	1678	*1,669*	3,347	454	*1,837*	2,291	2639	*3,775*	6,414	6,372	*9,087*	15,459
Latvia	468	*528*	996	776	*772*	1,548	343	*1,388*	1,731	133	*191*	324	1,720	*2,878*	4,598
Lithuania	893	*1,007*	1,900	435	*433*	868	364	*1,473*	1,837	118	*153*	271	1,810	*3,066*	4,876
Malta	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
Poland	4,316	*4,868*	9,184	6,524	*6,487*	13,011	3,695	*14,954*	18,649	10,383	*14,853*	25,236	24,918	*41,162*	66,080
Romania	1,629	*1,837*	3,466	1,385	*1,377*	2,762	2,568	*10,393*	12,961	1,208	*1,728*	2,936	6,790	*15,336*	22,126
Slovakia	939	*1,059*	1,998	499	*496*	995	892	*3,610*	4,502	2,392	*3,422*	5,814	4,722	*8,587*	13,309
Slovenia	360	*406*	766	1,149	*1,143*	2,292	1,073	*4,343*	5,416	230	*282*	512	2,812	*6,173*	8,985
Turkey	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
TOTAL	**14,096**	***15,897***	**29,993**	**16,680**	***16,586***	**33,266**	**13,815**	***55,912***	**69,727**	**28,544**	***40,699***	**69,243**	**73,134**	***129,094***	**202,229**

Note: OPEX have been calculated from known CAPEX values and average EU-15 CAPEX/OPEX ratios.

Table F.A5: Estimates of Capital Investment (CAPEX) by Environmental Investment-Heavy Directives

	Compliance Costs by Heavy-Investment Directives										
	Large Combustion Plants	**Vehicles**	**Air quality Framework**	**VOCs**	**Sewerage**	**Sewage Treatment**	**Drinking water**	**Closure landfills**	**Recycling/ Landfills**	**Hazardous Waste**	**IPPC**
Bulgaria	189	1,769	193	18	1,534	522	:	:	2,450	0	3,261
Cyprus							:	:			
Czech Republic	216	1,263	213	48	397	767	:	:	1,120	27	3,725
Estonia	312	273	42	59	119	49	:	611	72	15	489
Hungary	102	1,332	206	13	602	1,076			430	0	1,761
Latvia	43	375	68	25	408	171	197	281	51	11	90
Lithuania	74	745	126	22	250	185		117	237	10	44
Poland	3,456	3,300	861	22	4,860	1,554	110	2,070	1,539	86	6,927
Romania	402	1,145	430	155	1,385		:	:	2,494	86	806
Slovakia	796	784	118	54	170	329	:	:	870	74	1,596
Slovenia	180	319	21	20	914	:	235	321	477	275	50
TOTAL	**5,771**	**11,304**	**2,278**	**436**	**10,640**	**4,652**	**542**	**3,400**	**9,740**	**584**	**18,748**

Source: TME – 2000 (based on World Bank and PHARE DISAE estimates)
Note: Compliance cost for Malta and Turkey have not yet been estimated.