ANALYSIS FOR EUROPEAN NEIGHBOURHOOD POLICY (ENP) COUNTRIES AND THE RUSSIAN FEDERATION ON SOCIAL AND ECONOMIC BENEFITS OF ENHANCED ENVIRONMENTAL PROTECTION

REGIONAL SYNTHESIS REPORT: ENPI East

Synthesis report on: Armenia, Azerbaijan, Belarus, Georgia, Moldova, Russian Federation and Ukraine

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ACRONYMS

AQ..........................Air quality
BA ....Benefit Assessment
BAM ....Benefit Assessment Manual
BAP ....Biodiversity Action Plan
BAT..........................Best Available Technique
BAU ....Business as usual
BCM ....Billions of Cubic Meters per annum
BFT ....Benefit Function Transfer
BOD ....Biological oxygen demand
C&D.........................Construction and demolition
CBD ....Convention of Biological Diversity
CE...........................Choice Experiment
CH_4 ....Methane
CO ....Carbon monoxide
CO_2 eq. ....CO_2 equivalent
CO_2 ....Carbon Dioxide
COD ....Chemical oxygen demand
COD.........................Cost of Environmental Degradation
COI ....Cost of Illness
CV...........................Contingent Valuation
DALYs ....Disability Adjusted Life Years
DC ....Dichotomous Choice
DCCV ....Dichotomous Choice Contingent Valuation
DRF.........................Dose Response Function
E. coli ....Escherichia Coli
EC...........................European Commission
EE ....Energy efficiency
EEA.........................European Environmental Agency
EIA ....Environmental Impact Assessment
ENP ....European Neighbourhood Policy
ENPI ....European Neighbourhood and Partnership Instrument
EPA.........................US Environmental Protection Agency
EU ....European Union
FAO ....United Nations Food and Agricultural Organisation
GAR ....Ground Water Recharge
GDP ....Gross Domestic Product
GEF..........................Global Environment Facility
GES..........................Good Ecological Status
GHG ....Greenhouse gasses
GLASOD...................Global Assessment of Soil Degradation
GW ....Ground Water
HCA ....Human Capital Approach
HCV ....Human Capital Value
Hg...........................Mercury
IBA ....Important Bird Areas
IPA..........................Impact Pathway Approach
IPCC........................Intergovernmental Panel of Climate Change
IUCN........................International Union for Conservation of Nature
JMP ....Joint Monitoring Program

LCU..........................Local Currency Unit
MDG..........................Millennium Development Goals
MICS........................United Nations Multiple Indicator Cluster Survey
MOE........................Ministry of Environment
MOWI ....Ministry of Water and Irrigation
MSA ....Mean Species Abundance
MSW ....Municipal Solid Waste
NGO ....Non-Governmental Organisation
NH_3..........................Ammonia
NMVOCs ....Non-Methane Volatile Organic Compounds
NO_X ....Nitrogen Oxides
NPV ....Net Present Value
O&M ....Operations and Maintenance
O_3 ....Ozone
OECD.......................Organisation for Economic Cooperation and Development
PA............................Protected Area
PAH ....polycyclic aromatic hydrocarbons
Pb............................Lead
PE............................Population Equivalent
PM ....Particulate Matter
PPP..........................Purchasing Power Parity
RES..........................Renewable Energy Source
S ....Sulphur
SEA..........................Strategic Environmental Assessment
SEBI ....Streamlining European Biodiversity Indicators
SO_2 ....Sulphur Dioxide
SO_X ....Sulphur Oxides
SW...........................Surface Water
SWAR ....Surface Water Runoff
SWQS ....Surface Water Quality Standards
TARWR....................Total Actual Renewable Water Resource
TEV..........................Total economic value
TOE ....Tons oil equivalent
TPES ....Total Primary Energy Supply
UN...........................United Nations
USD ....United States Dollar
VOCs ....Volatile Organic Compounds
VOLY ....Value Of Life Years
VPF..........................Value of prevented Fatality
VSL ....Value of Statistical Life
WASH......................Water Supply Sanitation and Hygiene
WDPA......................World Database of Protected Areas
WEI ....Water exploitation index
WFD ....European Water Framework Directive
WHO ....World Health Organisation
WTP ....Willingness to Pay
WWT.......................Waste Water Treatment

1 INTRODUCTION

1.1 This report

This regional synthesis report has been prepared within the project '*Analysis for European Neighbourhood Policy (ENP) Countries and the Russian Federation on social and economic benefits of enhanced environmental protection*', initiated and supported by the European Commission's EuropeAid. This synthesis report was developed by the Institute for European Environmental Policy (IEEP), together with ARCADIS Belgium N.V. (project leader), Ecologic Institute, Environmental Resources Management Ltd (ERM), Metroeconomica Ltd and several independent experts. The report was fine-tuned in light of discussions at the regional workshop held on 23rd and 24th of June 2011 in Chisinau, Moldova.

The project covers the 16 European Neighbourhood Policy (ENP) countries and the Russian Federation (see Figures 1.1 and Box 1.1): Algeria, Egypt, Israel, Jordan, Lebanon, Libya[1], Morocco, occupied Palestinian territory, Syria and Tunisia (hereafter referred to as 'ENPI South') and **Armenia, Azerbaijan, Belarus, Georgia, Moldova, Russian Federation[2] and Ukraine (hereafter referred to as 'ENPI East' or as Eastern partner countries)**.

Under the project, a specific country benefit assessment has been conducted for each of the countries by a team consisting of an EU expert and a national expert, using a Benefit Assessment Manual developed under this project. This Benefit Assessment Manual which was originally for internal use, has been turned into a Benefit Assessment Manual for policy makers and experts for wider dissemination and provides an understanding of the methodologies applied for the country benefit assessments.

This is the synthesis report for the **ENPI East countries**. It builds on the country benefit assessments by: Grigol Abramia (International Center for Environmental Research) Emma Anakhasyan (consultant) Wim Van Breusegem (Arcadis) Corneliu Busoic (consultant) Renat Perelet (consultant) Sofya Solovyeva (consultant) James Spurgeon (ERM) Nataliya Stupak (consultant) Rafig Verdiyev (IHPA NGO) Sofie Willems (ARCADIS) and Yulia Yablonskaia (Ecoproject).

All project results, including the 16 country benefit assessment reports, the regional synthesis reports for ENPI South and East, for which this is the executive summary, and the Benefit Assessment Manual, are planned to be published on the project website www.environment-benefits.eu and to become available, upon request, from the European Commission's EuropeAid, DEVCO F3, Regional Programmes Neighbourhood East.

The overall aim of the project is to raise awareness of the value of the environment and ensure that the environment has its due place on the agendas of each government.

1 The benefit assessment report for Libya was cancelled due to the political situation in the country.

2 The Russian Federation is not formally part of the European Neighbourhood Policy, but holds a 'Strategic Partnership' with the EU. The ENPI financial mechanism provides assistance to both the ENP countries and the Russian Federation.

Its specific objectives are to improve awareness of the benefits of enhanced environmental protections within the ENPI countries and of their capacity to assess these benefits. In this way, the study is meant to support countries integrate environmental considerations into policy making and to mobilise financial resources for environmental improvements.

Figure 1.1 Countries in the ENP and strategic partnership (Russian Federation)

Source: European Commission http://ec.europa.eu/world/enp/partners/index_en.htm

Box 1.1 The European Neighbourhood Policy (ENP)

The European Neighbourhood Policy (ENP) was initiated in 2004, with the objective of strengthening the prosperity, stability and security of the EU and its neighbours. It consists of bilateral policies between the EU and 16 partner countries: Algeria, Armenia, Azerbaijan, Belarus, Egypt, Georgia, Israel, Jordan, Lebanon, Libya, Moldova, Morocco, occupied Palestinian territory, Syria, Tunisia and Ukraine. A strategic agreement was also signed with Russia – the Strategic Partnership with the Russian Federation.

From 1 January 2007 the European Neighbourhood Policy and Strategic Partnership with the Russian Federation have been financed through a single instrument - the European Neighbourhood and Partnership Instrument (ENPI), which was designed to target sustainable development and approximation to EU policies and standards. In May 2011 the two joint Communications: '*A partnership for democracy and shared prosperity with the Southern Mediterranean'* and '*A new response to a changing Neighbourhood'* (EC, 2011a,b) were published, with a renewed commitment to cooperation with the states in the ENPI region. The aim was to strengthen individual and regional relationships between the EU and the ENP countries by making additional funds available in exchange for more mutual accountability. Sustainable development –and environment - was one of the areas in which there was a strong commitment to make progress, as shown for example by the following extract: " The EU will join up efforts with its neighbours on climate change by enhanced co-operation to address low-carbon development and improve resilience to climate impacts (adaptation), The EU and partner countries should also pursue a higher level of the development of new partnerships on renewable energy sources and energy efficiency, and nuclear safety."

This benefit assessment aims to offer an evidence base to support the on-going dialogues and cooperation.

1.2 What are assessments of benefits of environmental protection?

An assessment of socio-economic benefits of environmental protection examines the potential positive outcomes for society that result from the adoption of environmental protection targets and the implementation of actions[3] to meet these targets. Such actions may include environmental policies, legislation and investments undertaken by government, industry or other stakeholders, who lead to environmental improvements (e.g. improved water quality from the construction of water treatment plans, reduced air emissions from better regulated industry and transport and so on).

Benefit assessments have played an important role in raising awareness of environmental problems, identifying possible solutions, highlighting the benefits of action and stimulating policy attention, focus and action. They have been undertaken in the context of EU enlargement[4], for cities and infrastructure investments[5] and more recently to emphasise the need to reduce biodiversity loss, invest in natural capital and to galvanise support for action[6].

The environmental benefit assessments undertaken under this project focused on identifying and analysing the potential benefits arising from the achievement of specific environmental protection targets identified for five thematic areas: Air, Water, Waste, Nature and Climate Change. The analysis involved the following:

- a description of the current status of the environment and how this is expected to change given current projected trends in socio-economic factors (e.g. mainly GDP and population changes);
- an assessment of the potential direction and magnitude of environmental change if specific environmental targets would be achieved;
- the identification, and where practical, quantification and monetisation of the benefits arising from such an environmental change.

The methodology applied for the country benefit assessments was developed under the project, building on previous analyses and methodologies, in particular on IEEP's ENP methodology (ten Brink and Bassi, 2007) and the World Bank's Cost of Environmental Degradation (COD) reports.

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3 It is therefore not a cost-benefit analysis. The study does not cover the costs of action.

4 Ecotec (2001) *The Benefits of Compliance with the Environmental Acquis for the Candidate Countries*; Ecolas and IEEP (2005) *The benefits for Croatia of Compliance with the Environmental Acquis*; Arcadis-Ecolas, IEEP, Metroeconomica, Enviro-L (2007) *Benefits for fYRoM and other countries of SEE of compliance with the environmental acquis*

5 See e.g., GHK, IEEP, Ecolas, Cambridge Econometric (2006): *Strategic Evaluation on Environment & Risk Prevention under Structural & Cohesion Funds for 2007-2013* - A report for DG Regio

6 *The Economics of Ecosystems and Biodiversity (TEEB)* see www.teebweb.org as well as TEEB 2008, 2009, 2010, 2011.

The methodology is described in a Benefit Assessment Manual for internal use by the project experts that contributed to the country benefit assessments. On the basis of this Manual, a Benefit Assessment Manual has been developed for a wide audience of policy makers in the ENPI countries.[7] This Benefit Assessment Manual provides an in-depth understanding of the methodologies applied under the project and is planned to be published on the project website www.environment-benefits.eu and to become available upon request, from the European Commission's EuropeAid, DEVCO F3, Regional Programmes Neighbourhood East, for organisations which may wish to explore further the benefits of improvement environment and/or carry out their own, more specific or detailed benefit assessments.

1.3 Aims of the benefit assessments

The benefit assessments that have been conducted under this project, intend to help the countries to evaluate the benefits of addressing environmental challenges it is facing and, where possible and appropriate, estimate their economic value – hence making benefits comparable and understandable to a wide audience.

The assessments provide 'order of magnitude' results, in order to communicate the scale and significance of the potential benefits to human health and well-being of reducing pollution, improving environmental quality, giving greater access to environmental infrastructure and of maintaining and/or investing in natural capital stock.

The benefit assessment reports aim to assist policymakers that are making a case for implementing and funding environmental policy actions and for environmental policy integration[8]. Environmental policy integration can help to avoid costs to the government and citizens, improving well-being and create growth and jobs, address a range of other key priorities – such as water security, food security, and provision of key environmental infrastructures. The reports aim to assist policymakers by providing new evidence and values on:

- key environmental issues affecting their country, i.e., the issues that could result in the greatest benefits if tackled appropriately;
- impacts of these issues on society – i.e., in terms of social (e.g., health), economic (e.g., additional social costs) and environmental (e.g., biodiversity loss) impacts; and
- benefits (health, environmental, economic and social) that accrue to society from taking actions to protect the environment.

[7] Bassi, S (IEEP), ten Brink, P (IEEP), Farmer, A (IEEP), Tucker, G (IEEP), Gardner, S (IEEP), Mazza, L (IEEP), Van Breusegem, W (EMS Consulting), Hunt, A (Metroeconomica), Lago, M (Ecologic), Spurgeon, J (ERM), Van Acoleyen, M (Arcadis), Larsen, B, Doumani, F. 2011. *Benefit Assessment Manual for Policy Makers: Assessment of Social and Economic Benefits of Enhanced Environmental Protection in the ENPI countries.*

[8] Environmental policy integration means making sure that environmental concerns are fully considered in the decisions and activities of other sectors, such as agriculture, tourism, industrial development, energy or transport.

The evidence base also helps in supporting those promoting action to achieve national and global objectives and targets – such as global commitments like the Convention of Biological Diversity (CBD) COP10 in Nagoya9; commitments to the Millennium Development Goals (MDGs) made at the WSSD meeting in Johannesburg and commitments under a range of Multi-lateral environmental agreements (MEAs).

Box 1.2 presents some examples of international key targets; for a wider discussion of targets see section 2.4 and the thematic chapters.

Box 1.2 National Commitments in a Global Context – examples: CBD Strategic Plan 2011-2020 and Millennium Development Goals (MDGs) of WSSD

MDG Goal 7 - Ensure environmental sustainability - is specifically focused on environmental sustainability. Sub-targets of relevance to the existing study include:

- Target 7A: Integrate the principles of sustainable development into country policies and programs; reverse loss of environmental resources;
- Target 7B: Reduce biodiversity loss, achieving, by 2010, a significant reduction in the rate of loss;
- Target 7C: Halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation.

The CBD Strategic Plan 2011–2020, includes 5 strategic goals and 20 targets. While all 20 are of relevance (see chapter 8), some key examples are presented below.

Target 5: By 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced.

Target 7: By 2020 areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity.

Target 8: By 2020, pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity.

Target 11: By 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.

Target 12: By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained.

Target 14: By 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable.

Target 15: By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification. *Source: CBD (2010)*

[9] The CBD Strategic Plan 2011-2020 includes 20 targets which include a range of targets of relevant to nature (biodiversity, forestry, degradation) – see chapter 8 of this report as well as ten Brink et al 2011 in TEEB 2011 and the CBD website.

The benefit assessment reports can play an important role in raising awareness regarding environmental problems, impacts and the benefits of action, by communicating these benefits and by making them explicit. The latter is crucial, as policy makers have often a clearer perception of what it costs to maintain the quality of the environment, than of the resulting benefits. As such the reports can stimulate policy attention, focus, action and appropriate funding.

1.4 Who can benefit from the benefit assessments?

The results of the benefit assessments have the potential to be of value to a wide set of organisations – see Table 1.1 below.

Table 1.1 Organisations that can make use of benefit assessments

Organisation	Potential use of Benefit Assessments
Governmental institutions, responsible for a sector that will directly benefit from environmental improvements	Governmental institutions, responsible for a sector that will directly benefit from environmental improvements, such as ministries responsible for environment, water, energy, land use, agriculture, fisheries, health, social affairs and tourism. This report provides evidence of the benefits of environmental improvements that can support their arguments for implementing and funding environmental actions and for environmental policy integration.
Governmental institutions that decide on funding levels	Institutions, for example ministries of finance, that play an important role in deciding the funding levels for each other ministry, are also a potential user of benefit assessments. This is important, as it is the perceived benefits that drive policy decisions to allocate public resources to maintain and to improve the quality of the environment.
Regional and local authorities	For similar reasons as the above mentioned governmental institutions.
Parliament	The benefit assessment reports can help legislators responsible for environmental matters to make the case for better environmental protection and conservation legislation.
The Judiciary (ministries of Justice); Environmental inspectorates/enforcement agencies	The benefit assessment reports provide evidence that supports their arguments for enforcing environmental legislation.
Local communities	The benefit assessment reports can help communities that depend for their livelihood on natural resources (e.g., forestry, fisheries) to demonstrate the value of the resources and the importance of preserving them, community management of community resources.
The private sector, civil society and the development partner community	The benefit assessment reports can help these stakeholders which jointly work on the common challenge of the transition to a resource efficient, effective, green and equitable economy, to set priorities for action. They also provide them with evidence when advocating for enhanced environmental protection.

1.5 Structure of the report

This report focuses on benefits in the ENPI East area. Benefits in the area of air are discussed in chapter 3, water supply and treatment in chapter 4, surface water quality in chapter 5, waste in chapter 6, chapter 7 on nature, and 8 on climate change. The methodology used is presented in detail in the Benefit Assessment Manual and in the country reports. A brief overview of the methodology is also provided in Chapter 2 below.

2 METHODOLOGY SUMMARY

This chapter introduces the methodological framework used under this project (see the Benefit Assessment Manual (BAM) for details) to identify the benefits of improving environmental conditions in the ENPI countries.

2.1 The benefits of an improved environment

The benefit assessments that have been conducted under this project focus on four categories of benefits from environmental improvements:

- **Health benefits**: these can also be interpreted as social benefits, but given the strategic importance to health of the enhanced environmental protection, they are assessed as a separate category. Direct benefits to public health include for example:
    - a reduction in the cases of illness and the avoidance of premature mortality arising from water-borne diseases;
    - a reduction in respiratory and cardio-pulmonary diseases and premature mortality associated with poor air quality.

- **Economic benefits**: these include for example:
    - economic benefits from natural resources (e.g. tourism benefits relating to protected areas, landscape, beaches, coral reefs);
    - eco-efficiency gains (e.g. improved fish provision from enhanced ecosystems that support fisheries directly and indirectly);
    - avoided costs (e.g. avoided costs of hospitalisation and lost days at work from health impacts; avoided climate change impacts);
    - the development of new and existing industries/sectors of the economy (e.g. renewable energy);
    - balance of payments and trade effects (e.g. reduced imports of primary material as more waste is reused and recycled);
    - increased employment through environmental investments (e.g., potential from developing the waste collection sector, from growth in eco-tourism).

- **Environmental benefits**: the uptake of environmental targets and actions clearly brings a direct benefit to natural assets. It should be noted that 'environmental benefits' are here considered distinct from the 'environmental improvements' the benefits stem from. In the BAM, environmental improvements are considered changes in the parameters related to the achievement of certain targets.

  For example, if the target of secondary treatment of all urban waste water would be reached, this would result in environmental benefits, such as improved surface water quality and avoidance of eutrophication, which can lead to biodiversity loss.

- **Social benefits:** benefits to individuals and society at large, including for example:
  - the safeguarding of, and access to, the natural and cultural heritage (e.g., through avoided pollution damage to historic buildings or the destruction of historic landscapes);
  - the safeguarding of the viability of (rural and coastal) communities and employment/livelihoods (e.g. in forest management, agriculture, fisheries, nature based tourism);
  - the enhancement of recreational opportunities (e.g., fishing and bathing),
  - increasing trust in quality environmental service provision (e.g., water quality);
  - improved social cohesion due to support for employment, social learning and the development of civil society (due to increased information provision, consultation and involvement);
  - poverty reduction and improved equality, tackling of rural-urban migration, and other (sustainable) development issues**.**

Specific examples of benefits associated with each area under analysis are presented in the benefit assessment manual (BAM) and in the latter chapters of this report.

The assessment of benefits includes elements which are related to the concept of ecosystem services i.e. the benefits that people obtain from biodiversity (ecosystems, species, and genes). Some of these services provide tangible goods (e.g. provisioning food or fibre); others provide non-market services such as regulating climate, opportunities for recreation, or supporting local cultural identity. Enhancing environmental protection will increase the capacity of ecosystems to provide such benefits (TEEB 2010, TEEB 2011) and therefore, these should also be taken into account in the analysis when relevant. Ecosystem services are grouped using a slightly different classification than the one used in this study. For clarity, in the box below we provide a brief overview of how ecosystem services are classified and how they relate to the approach adopted under this project and explained in the BAM.

Box 2.1 The theory of ecosystem services in relation to the benefit assessment method

Ecosystem services are the benefits that people obtain from ecosystems. According to the widely used classification developed by the Millennium Ecosystem Assessment (2005) and taken up in TEEB (TEEB 2010, TEEB 2011), these services can be categorised as follows:

- Provisioning services such as food, fibre, fuel, water and genetic materials.
- Regulating services i.e. benefits obtained from ecosystem processes that regulate our natural environment such as the regulation of climate, floods, disease, waste and water quality.
- Cultural services such as recreation, aesthetic enjoyment, tourism as well as cultural identity.
- Supporting services i.e. services that are necessary for the production of all other ecosystem services such as soil formation, photosynthesis, and nutrient cycling.

Although the BA encompasses more than the benefits from ecosystems, it is useful to clarify how the benefits from ecosystems - the ecosystem services - can be included in the study. The table below show a simplified categorisation of ecosystem services according to the BA's four benefit types

Table 2.1 Link between the BA benefits and MEA ecosystem services

BA benefits	Services Derived from the Millennium Ecosystem Assessment
Economic benefits	- Provisioning services (with no commercial value) – e.g. non-timber forest products, water provision - Regulating services (excluding disease regulation) – e.g. climate regulation - Supporting services (avoiding double counting with other services)
Social benefits	Regulating services: disease regulation; water and waste regulation
Health benefits	- Provisioning services (with commercial value) e.g. fisheries production; - Cultural services such as tourism; - Avoided costs of natural hazard management; - Avoided costs of water purification.
Environmental benefits	Cultural services, e.g. recreation; cultural identity

For a wider discussion of Ecosystem services and their value see TEEB (2008; 2009; 2010; 2011)

2.2 Scope of the assessments: environmental issues under analysis

The improvement of environmental conditions encompasses a vast range of environmental areas and policies. Clearly not everything could be covered by the project.

Given the large number of countries that were assessed under this project, a pragmatic approach was followed by focusing only on selected big issues, choosing a mix of environmental problems that were common across the regions, as well as country specific ones. The selection of issues (parameters) was guided by the need to identify issues of general importance which were sufficiently representative of the five environmental areas and simple enough to be assessed within the project. Other issues, beyond those included here, are clearly also important for some countries. Environmental related topics such as chemicals, nuclear waste, energy efficiency, desertification, mineral/fossil resources, marine fish stocks, and other country specific issues that could not be covered in this work could usefully be taken into account in future country benefit assessments.

It should be noted also that there are methodological limitations as to what can be assessed (e.g. at monetary level) given that many benefits are site specific[10].

The key environmental issues on which the analysis focused cover the five 'themes' - Air, Water, Waste, Nature and Climate Change (as a horizontal area).

For each theme there are also *sub-themes* (e.g. water - water infrastructure and water as a natural resource) identified and, for each sub-theme, smaller categories called '*parameters'* (e.g. connection to safe drinking water). The parameters are the 'smallest units' of the analysis, and the benefit assessment has been levelled at the parameter level.

10 For example natural capital's benefits for water purification, water provision and flood control are very site specific. Benefits transfer assessments need to be done with care and with sufficient data.

An overview of the themes, subthemes and parameters is provided in Table 2.2 below. (See BAM for the rationale for the choice).

Table 2.2 Overview of themes, sub-themes and parameters[11]

THEME	SUB-THEME	PARAMETERS
AIR	Air quality	1. Ambient air quality
WATER	Water - infrastructure and practice	2. Connection to safe drinking water
		3. Connection to sewage network and hygiene conditions
		4. Level of waste water treatment
	Water - natural resources	5. Surface water quality
		6. Water resource scarcity
WASTE	Waste collection	7. Waste collection coverage
	Waste treatment	8. Waste treatment
		9. Methane emissions from waste
NATURE	Biodiversity	10. Level of biodiversity protection
	Sustainable use of natural resources	11. Deforestation levels
		12. Level of cropland degradation
		13. Level of rangeland degradation[12]
CLIMATE CHANGE	Climate change drivers	Deforestation (covered under nature)
		Methane emission from waste (covered under waste)
	Climate change responses	14. Uptake of renewable energy sources
		15. Climate change adaptation (consider responses to 2-3 impacts among: sea level rise; sea temperature rise; desertification; water resource scarcity (covered under water);increased risk of pest or disease outbreaks; risk of forest fire; risk of flood; other effects

[11] Ecosystem services have been addressed within different parameters, and while there is an explicit discussion in chapter 7, the analysis is spread across chapters. Cultural services – recreation and tourism is covered under Biodiversity and Surface water quality); Carbon sequestration and storage is covered under Sustainable use of natural resources – on halting deforestation; and water provision and purification is covered under Water, and via case examples)

[12] Rangeland degradation was not covered in the country reports, since FAO data suggest that potential cost of rangeland degradation, and potential benefit of improvement, may be significant only in 4 out of the 16 countries under study (Jordan, Morocco, Syria and Tunisia). Therefore, for sake of comparability, the analysis focused only on the parameters that were relevant for all (or most of) the countries under study. A methodology for the assessment of rangeland degradation was , however, developed for the study, and is included in the BAM.

2.3 The level of analysis

The benefits arising from improved environmental conditions can in principle be analysed in three ways: qualitatively, quantitatively and monetarily - depending on the type and amount of information available.

1. In **qualitative terms;** providing a full description of the nature of the benefit, the people, land areas, sectors and services affected and, when relevant, an indication of the spatial distribution of the benefit (for example, as a map showing locations or regions in the country affected, or the neighbourhoods or social groups affected in urban areas). This is the easiest approach and is applicable to all parameters.

2. In **quantitative terms;** whenever quantitative data are available (e.g. cases of morbidity/mortality avoided etc.), to indicate the actual, relative or proportionate scale of the benefit arising from the environmental improvement identified. For example, the improvement of ambient air quality and/or water quality can lead to a quantifiable reduction in the number of cases of disease and early mortality. The improvement of water quality and protected areas management can lead to increase in the number of fish and in the number of bathers. Improved management and restoration of forests and wider green infrastructure around population centres can lead to the increased provision of cleaner water (quality and quantity). Reduced deforestation can avoid the loss of a certain amount of carbon and afforestation increase carbon sequestration.

   This approach is more data intensive and is applicable to several but not all the parameters, depending on the data available and the possibility to link environmental improvements to actual physical effects.

3. In **monetary terms**, when possible. This approach multiplies the quantitative benefits identified above by a money unit value (or a range of values) to give a monetary value of the benefit to society of a certain environmental improvement. Unit values include the value of a tonne of carbon, hospitalisation costs, value of a tonne of fish etc. The overall value to society can be the amount of money saved if a certain improvement is made (e.g. avoided hospitalisation costs from avoided illness across the population), market values of products or savings (e.g. increased revenues from fisheries locally or nationally, increased total value of carbon stored) or a measure of people's willingness to pay (WTP) for a benefit (e.g. for access to clean drinking water, river or bathing water quality). Such economic values may be obtained from cost data for specific services (e.g. cost of water treatments), market values for commodities (e.g. fish, carbon), survey data documenting WTP responses, modelling studies or benefit transfer studies. A discount rate can be applied to the monetisation of each benefit e.g. if Net Present Values (NPV) are used, but this was not the case in this study.

   This approach is the most data intensive and is applicable only to a smaller sub-set of parameters. There are also some methodological limitations which make the analysis of certain issues more difficult than of others, at certain scales. For example, assessing the benefits of water purification or flood control mitigation via natural capital (e.g. local forest or wetland) is possible for a city or town, but doing so for a country as a whole will either be majorly resource intensive (requiring case by case analysis for all major agglomerations), or methodologically questionable if using benefits transfer, as the benefits are so site specific. For carbon storage, on the other hand, a tonne of carbon can be taken as having the same value wherever it is stored, making assessing the value more feasible.

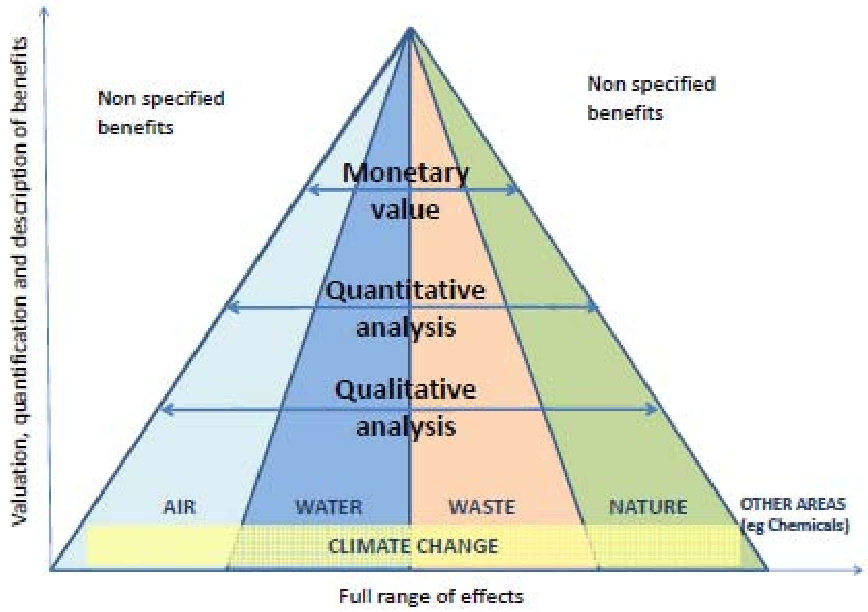
The adoption of this three-level approach is important as the availability of suitable data will typically vary between each parameter and between countries, and methodological tools are easier to apply for some issues than others.

The feasibility of undertaking complex quantitative and monetary analysis also depends on the scope of a BA and the resources and expertise available. In general, most benefits are identifiable in qualitative terms, a subset of them in quantitative terms and a smaller set in monetary terms.

This leads to a pyramidal assessment (see Figure 2.1 below) of the benefits of environmental improvements, whereby detailed values can be given for a small range of benefits while the value of several benefits remain unknown. This may result in many benefits being overlooked as no monetary value can be attached to them. For this reason it is important to ensure that the full range of benefits arising from enhanced environmental protection is portrayed to some extent, and that the BA is not constrained by focusing only on the elements that can be quantified or monetised.

A benefit assessment should therefore look at all of the three approaches, trying to develop a representative picture of the benefits. In some cases when national data do not allow a detailed analysis, local case examples can be valuable to help communicate issues relating to particular benefits. In any case, eventual future country assessments should also present the spatial perspective – indicating where the benefits occur and also, ideally, providing insights into spatial interconnectivity - e.g., which forest, grassland or wetland offers which services to which town or city; and where action in one area leads to benefits further afield (e.g., marine protected area and restoration helping fishing communities, reduced emissions from urban sewage leading to improvements to certain water bodies and leading to benefits to range of communities). Demonstrating the interaction between actions and beneficiaries can be important to support the implementation of given measures and their associated investment.

Figure 2.1 Benefits pyramid: qualitative, quantitative and monetary assessment



2.4 Methodology Steps

This section presents an overview of the key steps that were undertaken for the benefit assessments. The way these steps apply to each of the parameter is described in detail in the BAM.

The process to carry out a BA can be broken down into the following 5 main stages:

1. **Define the current state of the environment (reference point):** a description of the current environmental conditions is needed to establish a reference point against which one can assess improvement in the environmental parameters. This is done for the year for which the latest data generally available – 2008.

2. **Define the baseline to 2020:** under this step baseline projections of how the state of the environment is expected to change by 2020 have to be made, on the basis of projected developments in the underlying economic and demographic factors that affect the environment. This is required for a range of the parameters because, as the work will look at achieving certain targets in 2020, it will need to compare future improvements with future 'no (additional) action' scenarios. Key data for this step include, for instance, economic growth (GDP) and population growth. Within this study, given its timescale and resources, only very pragmatic baselines could be developed, focusing on only the key issues that were likely to affect the overall assessment (see BAM).

3. **Establish the targets:** in order to establish what the 'environmental improvements' could be, theoretical environmental targets to be met by 2020 have been set for each of the parameters to help in the assessment of benefits. Common targets have been set across the countries for each of the different issues. In a few cases, some country variants were also adopted to complement the cross country common assessment (e.g.

for RES). In other areas – e.g. halting deforestation by 2020 - the target only applied to a subset of nations and hence the focus moved to the value of the existing forest stock.

The targets are based mainly on selected international protocols, conventions and/or standards and, in some cases, on rules of thumb. An overview is provided in the table below. The targets are also presented in more detail in the BAM.

The targets are thus not explicitly related to actual policies existing in these countries (as this study was not doing an assessment of national policies), but should be seen as a theoretical indication of what an 'ideal' (yet feasible) environmental target can bring in terms of environmental improvements, to help assess and communicate the level of benefits. Clearly countries do not have the same policy aims, nor indeed do they have the same 'starting points', capacities and opportunities for progressing and implementing environmental policy agendas. In some cases existing political commitments will match those used as the basis of the analysis here, and in other cases the ENPI wide targets might be too ambitious or in other not ambitious enough. Some countries are thus likely to be able meet the targets earlier than others. Nevertheless, for assessment and comparability purposes, a common reference year (2008) and a target year (2020) were adopted. The target year is believed to be near enough to be politically relevant, but far enough into the future to allow significant progress with ambitious action. The objective was in any case not to do an assessment of country policies, or 'judge performance or plans', and it is recognised that many countries have made considerable efforts in recent years that may not be picked up by having 2008 data (and sometimes older, where 2008 was not available) as a starting point. Similarly a range of countries have recently launched important initiatives to improve the environment or to realise opportunities (e.g. renewable energies). The country benefit assessments aim to offer evidence to support the commitment to these initiatives and not as a statement that nothing is being done, as that is generally not the case. In any case, the benefit assessment methodology developed under the project, including the targets, can be adapted more concretely to national circumstances by stakeholders in the countries.

4. **Compare the targets to the reference point and baseline:** this step requires the identification of the expected environmental improvements that could be achieved if the targets were met, by comparing the proposed target for each of the parameter with the reference points and baseline. For some parameters the comparison with the reference point is key (e.g., as regards river quality, or protected areas covered) and in others the comparison with both the reference point and the 2020 baseline is necessary to obtain due insights (e.g., access to quality drinking water, as the number of people benefits will increase not just because of investments but also due to population growth).

5. **Assess the benefits:** this step requires the assessment of the range of benefits (health, environmental, social, economics) that would be achieved if the targets were met. This will require the use a combination of qualitative, quantitative and monetary approaches (according to the data available).

Table 2.3 Overview of selected targets for each parameter

THEME	PARAMETER	TARGET	Rationale for target
AIR	1. Ambient air quality	**WHO guidelines for SO_2 NO_x PM O_3 and CO Otherwise CO in Air Framework Directive**	Based on Gothenburg Protocol (GP) for ENPI East with specific targets. Others: e.g. WHO guidelines or GP-equivalent % reductions concentration.
WATER	2. Connection to safe drinking water	**100% connection (except isolated rural areas) to good water quality at tap *OR* (if info available) meeting WHO drinking water guidelines**	Rule of thumb - reduce the spread of water borne diseases, incidence of illness from poor water quality and social amenity of access to quality water.
	3. Level of sanitation and hygiene	**100% connection to sewage network (except isolated rural areas)**	Rule of thumb - major benefits from improved sanitation / hygiene in households.
	4. Level of waste water treatment	**100% secondary treatment in urban areas and main rural areas (>10,000 pop)**	Realistic target – primary treatment being insufficient to address environmental concerns, tertiary treatment being likely too advanced /costly.
	5. Surface water quality	**Various percentages of rivers and lakes improved to WFD good status (e.g. 85%, 65% etc. depending on current status)**	Inspired by EU Water Framework Directive & Bathing Framework Directive. Also: CBD COP10 Target #8: By 2020, pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity.
	6. Water resource use	**Lower Water Exploitation Index (WEI) by 20-40%**	Sustainable use and allocation is essential for meeting demand (at economic value, price of water). It depends on local conditions which most likely can only be established using a case study.
WASTE[13]	7. Waste collection coverage	**100% coverage of population with at least a bring-system for waste collection.**	Rule of thumb – modern environmental infrastructure for modern state.
	8. Waste treatment	**50% recycling (glass, paper, plastic, metals) 65% of biodegradable waste diverted from landfills**	Inspired by EU waste legislation.
	9. Methane emissions from waste	**Up to 50% capture**	Considered a reasonable level and used in previous benefit studies.
NATURE	10. Level of biodiversity protection	**Two area targets: reach at least 17% of total land area and 10% marine area covered by protected areas (PA);**	Johannesburg WSSD target, MDG: slow biodiversity loss + CBD COP10 Strategic Plan for 2011-2020: Target #11 - 17% land area, 10% marine area covered by protected areas.

[13] Waste prevention is a key factor of the EU waste management strategy and should be a key factor in any waste management strategy. However, for methodological reasons, the benefits of waste prevention have not been assessed under this project.

THEME	PARAMETER	TARGET	Rationale for target
		100% of PAs in favourable condition status.	
	11. Deforestation levels	**Halt deforestation by 2020**	CBD COP10 Strategic Plan target #5: By 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced.
	12. Level of cropland degradation	**Improve land quality to reduce crop yield losses by a half**	
	13. Level of rangeland degradation	**Improve rangeland fodder productivity to reduce degradation occurred by a half**	
CLIMATE CHANGE	Deforestation	*(covered under nature)*	Preserve carbon storage and sequestration values of forests – *Green carbon.*
	Methane emission from waste	*(covered under waste)*	Methane, a key green house gas (GHG), has high global warming potential (GWP).
	14. Uptake of RES	**At least 20% of energy demand supplied by RES by 2020**	Inspired by EU policy.
	15. Climate change adaptation	**Keeping temperature rise to 2 degrees Celsius**	International Panel for Climate Change (IPCC)

Note: As an exception, in some countries sensitivities can be applied to the targets to assess other 'ambitions', where considered doable and offering useful value added, and should ensure that results are meaningful, notably where the targets above are obviously inappropriate for a country given its current situation (e.g., already beyond the 20% RES target).

As noted above, the targets reflect a range of actual commitments (e.g. CBD Strategic Plan), contributions to objectives and targets (e.g. MDGs), and areas where commitments could be forthcoming (e.g. for renewable energies, where not all countries have set targets). The choice of 'targets' within this study has been made to facilitate an assessment of benefits so as to derive insights on the benefits of potential environmental improvement. National targets will in some cases coincide with the targets chosen in other areas there will be quite some country variation (and country targets are naturally also dynamic as they are regularly revised). In summary, the targets should be seen as useful tools for assessment and development of a useful evidence base for countries, and not a policy recommendation for countries, as this is clearly outside the scope of this assessment.

It should be noted that the methodology used in this study (and described in the BAM) is but one of the possible pragmatic approaches to translate benefits into actual values. Other methods are also possible and more sophisticated and accurate approaches may also be more feasible in the future, when better data and analytical tools become available, or when resources to explore issues in more depth become available.

2.5 Interpretation of the results

As each country is characterised by its own economic, political and social conditions, and as the basic data used in these analyses are not always comparable across countries, one should not compare/benchmark countries against one another and the benefits calculated here should be seen in their context. Similarly the regional totals should be seen as illustrative estimates, and. The values, however, should prove a useful additional evidence base on importance of improving the environment. What the exact value will be will depend on national choices as to the paths to a green economy.[14]

The ambition of this study was to provide indicative values for improving the environment across a range of parameters. This built on data that in many areas were robust, but in others weaker. A range of often pragmatic assumptions were adopted in the study given the need for comparable treatment across the ENPI countries and given the limited resources.

When interpreting the results expressed in monetary terms, it should be borne in mind that these are derived from a mix of market and non-market values. The market values will directly affect GDP (e.g. capturing the value of improved agricultural output). There are other effects – such as a reduced risk of suffering from chronic bronchitis – for which no market prices exist, and so do not affect GDP, but which people value. These values can be estimated through various methods and are used to present benefit estimate results in monetary terms in order to help communicate the importance of the issues.

Furthermore, where values relate to benefits related to international process (i.e. carbon prices used as regards climate change mitigation) the values are in Euros, and where they relate to e.g. health benefits associated with avoided impacts of air pollution, or other benefits, they are in € PPP (Purchasing Power Parity). PPPs are widely used as an alternative to monetary exchange rates when making international economic comparisons. They are, in effect, 'real' exchange rates, based on a comparison of the relative purchasing power of each country's currency. Purchasing power parities equate the purchasing power of different currencies. This means that a given sum of money, when converted into different currencies at the PPP rates, will buy the same basket of goods and services in all countries, thus eliminating differences in retail price levels between countries.

The range of carbon values used in this project derives from different sources. For an assessment of avoided damage, the marginal value of damage from a tonne of carbon can be used and is a non-market value obtained from modelling the marginal change to the aggregate impacts of climate change in monetary terms as a result of the additional tonne of carbon emitted. Alternatively, for the assessment of costs of action to reduce carbon

[14] Countries also have a range of specific interests not just in the fields covered in this report, but more widely (e.g., energy efficiency, desertification, chemicals), or needs for particular depth on issues covered here (e.g. jobs, rural livelihoods and poverty; or natural capital and tourism). Not everything could be covered by the existing study, and this should not be taken as a study judgement as to whether something is important or not - all environmental issues merit attention and it is a question of data, resources and tools. There is a growing discipline of benefit assessment and even in difficult areas (e.g. chemicals) which should become increasingly accessible for benefit assessment in due course.

emissions, national marginal costs of emission reductions can be used, or if trading markets exist, then a Clean Development Mechanism (CDM) or trading price could be used (e.g. EU-emission trading scheme (ETS) price), to the extent that there is market access. This selection of values can quickly get complicated by the range of estimates available, and some countries have offered guidance values. Broadly speaking, these guidance values present marginal damage cost estimates that are higher than the costs of national action. Whether these latter cost estimates are higher or lower than the market prices given depends on the strictness of the emission targets/objectives and potential for action in both the domestic domain and in the carbon markets. In all cases the values will change over time.

Finally, those values relating to wellbeing and human health (e.g. avoided bronchitis or diarrhoea from polluted air or water, and avoided early mortality), have been applied using a conventional benefits transfer approach. In this approach, a value derived in one country (e.g. the willingness to pay to avoid bronchitis) is ‘weighted’ by the relative GDP/capita between the country from where the value was derived and the ‘target’ country, in this study one of the ENPI nations. While this is acceptable at one level – peoples' willingness to pay for clean drinking water does tend to be broadly related to income levels (and GDP/capita a proxy for this), for health this is sometimes regarded as controversial - most notably with regard to the value of avoiding early mortality from pollution. In this case, this approach can lead to the interpretation that lives in countries with lower GDP/capita are in some sense not valued as highly as those in countries with higher GDP/capita. To avoid this complication, it is best, ideally, to use national willingness to pay estimates of ‘values of prevented fatality’. Where these are not available, the conventional benefits transfer approach with weighting may be used, noting clearly - to avoid misinterpretation - the caveat that the transferred estimate is an approximation, only, of the preferences of the citizens in the target country. Alternatively, where income levels between the original country and the target country are not too disparate, it is defensible (from an economic perspective) to use the original value, unadjusted by weighting given the substantial uncertainties still remaining in the empirical estimation of such values. It is also of course defensible (from a moral perspective) to have no GDP/capita weighting. In either case, care must be taken to be transparent as to the method and assumptions and not to confuse the instrumental benefit of an economic assessment (highlighting that lives should be protected) with the unintended consequence following from the mis-interpretation of ‘value of lives varying across nations’ (where ‘traditional’ GDP/capita weighting is applied). As a final cautionary note, it is likely to be the case in practice that if no assessment is done, the risk of losing lives is higher since the health effect may be under-valued in a policy appraisal. So whilst if valuations are used (as they are here) then one faces the controversy, the potential to save lives arguably merits the controversy.

3 AIR QUALITY

Key Messages: Air

- Air quality is currently a significant environmental hazard across the ENPI East, in particular in larger cities, resulting in sizeable negative impacts on public health, ecosystems, crops and materials.
- Principal benefits resulting from reduced emission levels of a range of pollutants include: improvements in human health (pulmonary and cardiovascular illness); higher crop yields, (important crops include potatoes, barley and wheat), and; reduced soiling of building materials. Air pollution impacts on ecosystems and cultural heritage would also be reduced as a result of lower emissions.
- Total emission reductions of sulphur dioxide, nitrogen oxides, particulates, volatile organic compounds and ammonia as a result of a 50% reduction from projected 2020 levels in all the Eastern ENP countries are presented in the Table below.

Air pollutant emission reductions in ENPI East countries *(thousand tonnes)*

NH3	NMVOC	NOx	PM2.5	PMco	PM10	SO2
840	5079	2518	674	413	1087	3932

- As a result of these emission reductions, the total quantified benefits realised domestically as a result of each country's reductions could be as much as €200 billion per year, of which 90% would be realised within Russia, as a result of the emission reductions in that country (higher bound estimate)[15]. The numbers of premature deaths and cases of chronic bronchitis avoided would be in the ranges of 30,000 – 90,000 and 50,000 – 160,000 respectively.
- According to first indicative estimates made here, benefits of similar size could be realised per annum in 2020 if changes in impacts that result outside national borders (some in neighbouring ENPI countries, others outside the ENPI region) as a result of domestic reductions were also considered. Benefits to human health are estimated to account for around 90% of all the quantified benefits, due to reductions in the incidence of respiratory and cardio-pulmonary illnesses.
- These results suggest that – as being initiated in many of these countries – future regulation should address both stationary (industry, energy) and non-stationary (in particular old vehicles) sources and consider technological options as well as spatial planning.
- Future research should focus on more detailed, context-specific modelling of the air quality impacts, as well as using this information to conduct cost-benefit analyses of alternative strategies to improve air quality.

[15] This reflects the high end of the range of values estimated in Russia, which is 182bn – i.e. 90% of the high end €200bn total for ENPI East. Note that the results in the country reports only reflect central results whilst the regional reports report the full ranges, reflecting the modelled uncertainties.

Key Messages: Air
• Air quality strategies are likely to be more cost-efficient if they are designed to exploit synergies that exist with climate change policies that regulate greenhouse gas emissions. Such synergies should therefore be recognised in the design of national and regional environmental policies.

3.1 Ambient air quality

3.1.1 Introduction

This sub-theme assesses the aggregate benefits from improved air quality resulting from changes in the ambient levels of a number of pollutants including ozone, (O_3), particulates, (PM)[16], volatile organic compounds (NMVOCs), sulphur dioxide, (SO_2), nitrogen oxides, (NO_x), and ammonia, (NH_3). Air pollutants may be released by either stationary sources such as those emitted from the stack of a coal-fired power plant or of an industrial facility, or by moving sources which include, for example, automobiles, buses, trucks, rail and ship transport.

Air pollution causes a wide range of human health, social, economic and 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. As a consequence, regulation of the emissions of such pollutants through the design of public policy is spreading and strengthening globally.

In this project, we derive estimates of the benefits from reducing emissions of the pollutants listed above by 50% from projected baseline levels. The size of this reduction is broadly consistent with those applied in previous analyses of environmental regulation in EU and other neighbouring countries (Ecotec et al., 2001). This reduction is intended to be broadly representative of that which might result from adopting the level of regulatory effectiveness currently being implemented in the EU and North America.

3.1.2 Current status in the region

The pollutant emission levels in 2005 in the Eastern ENPI countries are presented in Table 3.1 and Table 3.2. The two tables show that the emissions in Russia are larger than for the other countries combined, whilst Ukraine and Belarus are the next largest emitters of these pollutants. This pattern reflects the size of the countries' individual populations, and their patterns of economic activity. For example, in Ukraine air pollutants are emitted principally

[16] Includes PM2.5, (particles less than 2.5 micrometers in diameter, often known as 'fine particles') PM10 (particles less than 2.5 micrometers in diameter), and PMco (particles greater than 10 micrometers in diameter)

from metallurgical industries, mining, and oil processing sectors as well as from transport. In all these countries, rising levels of car ownership – combined with poor levels of maintenance of an ageing car fleet – is an important contributory factor in determining air pollution levels[17]. A national perspective on current air quality is given by the example of Georgia in Box 3.1.

Box 3.1 Current air quality status: Georgia

Based on available data, concentrations of the priority pollutants (SO2, NO2, CO and in Zestafoni - MnO2) exceed the legal limits in all Georgian cities where monitoring occurs. For example, average concentrations of PM10 in 2008 were: Tbilisi 0.5; Kutaisi 0.9; Batumi 0.5 and Zestaphoni 0.5 µg/m3.However, there are no data available on the size of the population exposed to those high concentrations of pollutants. Scarcity of data seriously impedes proper planning and decision making. Air quality monitoring is inadequate, which is a major concern.

A number of factors are responsible for the **transport** sector's pollutant contribution, including:

- Insufficient development of public transport in most cities and regions resulting in an increased number of private car vehicles.
- Due to low income levels in rural Georgia, people are forced to buy used cars. Most of the cars are older than 15 years and their emissions are much higher. Even though most cars are imported from Europe, the catalytic converters are usually removed, increasing the pollutant emissions.
- Regular technical vehicle inspection has been waived for some time. As a result, many cars are in poor technical condition and consequently, emit more pollutants.
- Some low quality fuels available on the market cause damage to the catalytic converters of vehicle exhausts. Car owners tend to have the damaged catalytic converters removed and not replaced, resulting in higher emissions.
- Few cities have a traffic optimization system, which leads to frequent traffic jams, and thus higher fuel consumption and emissions.

Historically, the major **industrial** sources of air pollution in Georgia were:

- metallurgical plants in Rustavi and Kutaisi: After the breakup of the Soviet Union, the metallurgical plants ceased operation.
- cement plants in Rustavi and Kaspi: Recent installation of modern dust abatement systems has reduced emissions of dust emissions by 75%.
- Ferro-alloys plant in Zestafoni: a dust abatement system is to be installed, but the plant is still the major pollution source in the region because of high levels of manganese oxide emissions. Because of the costs associated with air pollution abatement equipment and because the plant is the main employer in a poor region, it was given an extension until 2013 to meet emissions standards.

The **energy** sector in Georgia consists mainly of three large power stations located in Gardabani, mainly working on gas. Since the municipal power companies were dissolved in the 1990's, the heat

[17] Note that transport is also responsible for emitting other pollutants such as NO2, CO and CO_2 that are not included in Table 3.1.

Box 3.1 Current air quality status: Georgia

distribution systems in big towns and other settlements have virtually been eliminated. The population now uses individual heating systems, working mostly on gas and wood. Volatile organic compounds (VOC's), carbon monoxide (CO) and solid particulates (dust) are the main pollutants from the energy sector. Changes in emissions are mainly caused by changes in the fuel consumption patterns, where coal and mazut (heavy residual fuel oil) are considered to be dirtier, and natural and liquid gas, to be cleaner fuels.

Table 3.1 Pollution emissions by country in 2005 (thousand tonnes)

	NH3	NMVOC	NOx	PM2.5	PMco	PM10	SO2
Armenia	17	101	6	16	10	26	8
Azerbaijan	64	318	76	18	9	27	135
Belarus	165	366	84	29	14	43	134
Georgia	39	68	16	7	3	10	5
Moldova	21	73	14	25	21	46	7
Russian Federation	1068	8394	4297	947	569	1516	6710
Ukraine	306	838	544	305	202	507	863
Total (rounded)	1680	10159	5036	1348	827	2175	7863

Sources for baseline emissions: European Commission, Joint Research Centre (JRC)/Netherlands Environmental Assessment Agency (PBL). Emission Database for Global Atmospheric Research (EDGAR), release version 4.1. http://edgar.jrc.ec.europe.eu, 2010'; Megapoli, contributed by TNO, 2010

Table 3.2 GHG emissions by country in 2005 (thousand tonnes)

	CO_2 emissions ('000 tons)	Methane emissions ('000 tons of CO_2 equivalent)	Nitrous oxide emissions ('000 metric tons of CO_2 equivalent)	Other GHG emissions, HFC, PFC and SF6 ('000 tons of CO_2 equivalent)
Armenia	4367	2300	450	10
Azerbaijan	35024	11550	4040	50
Belarus	68799	16620	10360	440
Georgia	5514	4330	3390	10
Moldova	7815	2590	970	360
Russia	1563531	501380	42650	56600
Ukraine	318926	75640	23270	1390
Total	2003977	614410	85130	58860

Note: CO_2 emissions for 2006. Source: World Bank 2010. World Development Indicators.

3.1.3 Benefits of improving air quality – qualitative assessment

The variety of benefits of improving the currently projected air quality baseline includes those listed in the table below.

Table 3.3 Qualitative description of benefits of reductions in air pollution

Environmental benefits	Description
Ecosystem condition improvements	– Reduced acidification from lower SO_2 and NO_x emissions – Reduced climate change impacts on impacts from lower SO_2 and NO_x emissions – Reduced damage to vegetation from low level ozone
Health benefits	**Description**
Lower incidence of acute and chronic disease	– Reductions in SO_2 imply lower incidence of cardiovascular and respiratory disease – Reductions in PM_{10} concentrations imply lower emergency-room visits due to asthma, and also hospital admissions on the grounds of respiratory diseases – Reductions in NO_x, when combined with ozone, organic compounds, particulates and sunlight result in corresponding reductions of photochemical 'smog' that otherwise cause respiratory impairment, irritation of the eyes and mucous membrane, with asthma patients and young children.
Social benefits	**Description**
Improved quality of life	– Reduced health effects – increased visibility in urban areas, as a result of reduced photochemical smog – Transport emissions are a major contributor to poor urban air quality and compliance with them is one component of any comprehensive social improvement policy.
Increased amenity value of improved landscapes, nature and air quality	– through reduced pollution pressure
Reduced damage to cultural heritage, including among other things, historic building surfaces in city centres.	– 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. – Exposure of building materials to SO_2 deposition from acidification results in premature ageing. – Reduced blackening and erosion of surfaces (from SO_x and NO_x emissions from traffic fuel use), can improve the social appreciation and use of city centres and cultural heritage.
Economic benefits	**Description**
'Green technology' industries	– Increase in demand for products and processes that result in lower air pollution emissions, and subsequent employment opportunities, as long as such industries are domestic.
Increased visits to improved landscapes and natural areas	– Increase in tourism and associated expenditures in local areas.
Lower material cleaning costs	– Reductions in expenditures on building surfaces soiled by particulates.
Crop damage reductions	– Reduced crop damage from lower SO_2 and NO_x emissions – Reduced crop damage from low level ozone

3.1.4 Benefits of improving air quality – quantitative and monetary assessment

On the basis of modelling work undertaken in the project broad quantitative estimates of the benefits have been derived of meeting the target of 50 per cent reduction in pollutant emissions (SO_2, NOX, PM, NMVOCs and NH_3) from the 2020 baseline. Quantification is of the physical health impacts as well as of overall monetary benefits that include health, crop and material impacts. Table 3.4 presents the estimates of physical health benefits, expressed in terms of the number of premature deaths avoided and the numbers of cases of chronic bronchitis (equivalents) avoided in the individual country from emission reductions in that country[18]. Whilst there have been very few previous studies undertaken in this region, one study by Strukova et al (2006), that assessed the total damage costs that can be attributed to air pollution in Ukraine, generated an estimate of 22,000 - 27,000 excess deaths. This accords well with the upper end of the range for Ukraine presented in Table 3.4, which estimates the benefits of a 50 per cent reduction in air quality impacts. Table 3.4 also shows that the majority of health benefits in the ENPI East region are realised in Russia.

Table 3.4 Physical premature mortality and morbidity impacts avoided in year 2020

	Deaths			Chronic Bronchitis Cases		
	Low	**Central**	**High**	**Low**	**Central**	**High**
Armenia	104	180	338	249	430	806
Azerbaijan	231	400	750	578	1,000	1,875
Belarus	971	1,680	3,150	2,313	4,000	7,500
Georgia	104	180	338	231	400	750
Moldova	451	780	1,463	925	1,600	3,000
Russian Federation	21,969	38,000	71,250	41,625	72,000	135,000
Ukraine	4,741	8,200	15,375	9,134	15,800	29,625
Total	**28,571**	**49,420**	**92,663**	**55,055**	**95,230**	**178,556**

Table 3.5 expresses the benefits of avoided premature mortality in terms of each country's population. Again, Russia has the highest benefits across the countries considered in this modelling exercise.

Table 3.5 Annual deaths avoided per 100,000 population

Country	Annual deaths avoided
Armenia	6
Azerbaijan	5
Belarus	17
Georgia	4
Moldova	21
Russia	27
Ukraine	18

[18] Note that whilst the individual country reports present central estimates only, in this report we represent the uncertainty in all stages of the modelling (including emission dispersion, exposure-response functions and monetary valuation) in presenting 'low' and 'high' estimates. The extent of this range is determined by the findings of uncertainty analysis in the EU context.

Table 3.6, below, shows the estimated benefits in monetary form – both in terms of million Euros and in terms of what these Euro totals equate to as percentages of projected GDP in 2020. The results serve to validate previous monetary estimates that have been made in the region, notably those by Strukova et al. (2006) that found total damages from air pollution to equate to 4% of GDP. It is notable that Moldova has relatively high benefits, possibly reflecting relatively high levels of car ownership and the siting of industry close to urban centres. The benefits accrue to the four impact categories in the following proportions: mortality, (70% of the totals), morbidity, (20%) crops, (6%) and building materials (4%).

Air pollution modelling in Europe has repeatedly shown that – due to their dispersion by atmospheric wind currents - the emission of pollutants in one country may result in significant impacts in other countries within certain geographical areas. Consequently, we have made initial estimates of these trans-boundary effects. The results are presented in Table 3.6 and 3.7 below and show that they may be at least as large as domestic impacts. There is considerable uncertainty in these results and they should be treated as indicative only. Nevertheless, they serve to demonstrate the potential importance of such effects.

Table 3.6 Annual Compliance: Domestic Benefits – 2020

	€ million PPP			**per cent of GDP**		
	Low	**Central**	**High**	**Low**	**Central**	**High**
Armenia	71	123	231	0.3	0.6	1.1
Azerbaijan	227	393	736	0.3	0.5	0.8
Belarus	1,333	2306	4,323	1.2	2.0	3.8
Georgia	57	98	184	0.3	0.5	0.9
Moldova	146	253	475	1.4	2.5	4.6
Russia	56,394	97,547	182,900	1.8	3.1	5.8
Ukraine	3,845	6,650	12,469	1.2	2.1	3.9
Total	**62,073**	**107,370**	**201,319**	**0.9**	**1.6**	**3.0**

Table 3.7 Annual Compliance: Trans-Boundary Benefits – 2020

	€ PPP			**% of GDP**		
	Low	**Central**	**High**	**Low**	**Central**	**High**
Armenia	72	124	233	0.3	0.6	1.1
Azerbaijan	157	272	509	0.2	0.3	0.6
Belarus	348	603	1,130	0.3	0.5	0.9
Georgia	71	123	230	0.3	0.6	1.1
Moldova	162	280	525	1.6	2.7	5.1
Russia	31,354	54,235	101,690	1.0	1.7	3.2
Ukraine	5,492	9,499	17,811	1.7	3.0	5.6
Total	**37,656**	**65,135**	**122,129**	**0.8**	**1.3**	**2.5**

3.2 Conclusions – Air related benefits

The project has confirmed that air quality is currently a significant environmental hazard across the Eastern ENPI countries. International research has previously established that air pollution causes a wide range of human health, social, economic and 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 (i.e. many hundreds of kilometres) 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 analysis of projected emissions of particulates, Nitrogen Oxide, Sulphur Dioxide, Non-Methane Volatile Organic Compounds and Ammonia that considers human health, crops and damage to building materials has shown that there are substantial benefits to be gained from the reduction of these emissions within the ENPI East countries. Based on the high results presented above, total domestic benefits (i.e. benefits realised in the individual countries in which the emissions are being reduced), of reducing emissions of these pollutants by 50% from their projected 2020 levels in all the Eastern ENP countries could be as much as €200 billion per year. Just over 90% of these benefits would be made within Russia, as a result of the emission reductions in that country. According to the estimates made here, benefits of similar size could be realised if trans-boundary impacts (i.e. impacts that result outside national borders as a result of domestic reductions) were also considered. Benefits to human health are estimated to account for around 90% of all these benefits.

The low and high ranges of results that are presented in the tables above reflect the modelled uncertainties. They do not, however, reflect the additional uncertainties that are introduced in the process of transfer of results from previous studies (e.g. in epidemiological exposure-response functions and monetary valuation) that were undertaken in non-Eastern ENPI countries. Contextual differences such as these may well be important. Similarly, it should be highlighted that the air quality modelling is limited in the number of pollutants incorporated, since it does not include NO2, Heavy Metals, PAHs etc., and does not consider all the potential impacts. Potentially important impact categories that are not considered quantitatively include ecosystem damages; again, these are thought to be important. At the same time, it should be noted that the methods and data needed for quantification of air pollution impacts are more advanced than for other environmental themes considered under this project (e.g. water, nature etc.). As a consequence, the quantitative results for air are more complete than other media and cannot be directly compared in order to prioritise regulatory resources across media.

The project has indicated that the benefits of reducing emissions of air pollutants by 50% in 2020 in the Eastern ENP countries are significant to the welfare of the populations of these countries. The central country-specific results show a range of benefits to these countries equivalent to between 0.5% and 3.1% of national GDP. Accounting for trans-boundary impacts may double these totals.

The range of results reflects patterns of economic activity in these countries, including their industrial composition, the proximity of population centres to large polluting enterprises, and patterns of car ownership and the age and maintenance regimes of such vehicles. These results therefore suggest that – as being initiated in many of these countries – future regulation should address both stationary, i.e. point, sources and non-stationary, i.e. transport, sources and consider technological options as well as spatial planning. Future research should focus on more detailed, context-specific modelling of the air quality impacts, as well as using this information to conduct cost-benefit analyses of alternative air quality regulatory strategies.

4 WATER

Key Messages: Water
• Provision of a centralised drinking water supply varies across the Eastern ENP countries. For urban populations, the highest levels of provision are found in Armenia and Belarus and the lowest in Azerbaijan and Moldova. For rural areas the there is more variation between countries. In Armenia and Belarus over 70% of rural populations have access to piped water supplies, but this is between 20 and 25% in Azerbaijan and Ukraine. • The level of connection to the sewage network also varies. In some urban areas this can be relatively high. However, for rural populations the degree of connection to sewage networks is much lower and there are significant proportions of the rural populations without access to any form of improved sanitation. • Meeting targets of full piped connection to drinking water and sewage collection would mean an additional 53.58 million people would have reliable and safe piped water to premises, and an additional 85.76 million people would have connection to a sewage network system in 2020. This will be beneficial in particular in poor rural and urban areas. • Overall, across the region, the benefits that would accrue from improved drinking water quality and sewage connection would be between 31 million and 66 million annual cases of diarrhoea avoided and between 832 and 1,674 deaths avoided. • The annual monetised benefits that would accrue from improved drinking water quality and sewage connection would be between €4,772 million and €10,376 million for morbidity (illness), between €836 million and €1,740 million for mortality, which would give total annual benefits of between €5,607 and €12,115. These benefits represent between 0.14% and 1.08% of the GDP of individual countries. • Surface water quality varies, with many water courses suffering from pollution, often from old or inadequate infrastructure. Improving this would bring significant benefits for residents and users, such as fishermen, property values, etc. • The benefits of meeting water quality improvements vary between €30.7 and €229.4 PPP per household (HH) year, which corresponds to 0.11-1.73 per cent of the GDP of individual countries. Water scarcity is also a problem is some parts of the ENPI East (particularly in the southern regions, e.g. in countries such as Armenia and Azerbaijan). Droughts cause significant economic damage and better water management would bring additional economic, as well as social and environmental benefits.

4.1 Overview

Waters in this region not only form a critical foundation for ecosystems, health and social and economic well-being, they also have a deep connection with social and political identities. The vast rivers of European and Asian Russia, some flowing to Belarus and Ukraine, have helped shape social development and identity.

All of the countries are former republics of the Soviet Union. While there are social characteristics relating to behaviour in relation to water that predate this period, all of the infrastructure and the foundations for economic pressures such as agriculture find their origin in Soviet planning. These foundations included provision of drinking water systems, some waste water collection and treatment and the adoption of standards for these. However, economic transition has been diverse in these countries and in some cases modernisation has occurred, while in others the infrastructure is not only out of date, it has also ceased to function (see also DA, 2002).

Many regions of the countries included in this report do not exhibit water scarcity. Indeed, regions of Belarus and Russia are characterised by extensive areas of rivers and lakes. However, water scarcity is an issue in parts of Moldova, Ukraine and the Caucasus. Indeed, major hydrological schemes were developed in the past to address some of these issues, e.g. transport of water in the Crimea. Climate change has the potential to exacerbate some of these problems, not only through changes to precipitation and evapotranspiration, but also with changes to snow melt affecting patterns of run-off.

All of the countries in the region share transboundary waters with neighbouring countries – inside and outside the scope of this report. Russia is downstream of some transboundary rivers from neighbours outside the scope of this report, but is upstream of a number of countries included here (particularly Belarus and Ukraine). There are significant transboundary water courses between Belarus, Moldova and Ukraine and also between the three countries of the Caucasus. Measures to improve the quality of water bodies and improve water use efficiency will, therefore, in many cases provide additional benefits to neighbouring countries and, conversely, some benefits from improved water quality will require measures to be adopted in neighbouring countries.

It is important to note that a number of rivers are transboundary with and/or into EU Member States. This is the case along most of the border with the EU. This study has only sought to identify benefits arising from improved environmental performance in the countries of the ENPI East and Russia. Therefore, it must also be emphasised that such improved environmental performance would also have additional benefits for some EU Member States (and, indeed, some further third countries).

This chapter begins by considering the benefits from improving access to safe drinking water and connection to sewage connection. It continues by examining the benefits from improved waste water treatment. It then analyses the wider benefits that would arise from improvements to the quality of water bodies and concludes with a consideration of the benefits from addressing the issue of water scarcity.

4.2 Connection to safe drinking water and connection to sewage network and hygiene conditions

4.2.1 Introduction

A major cause of disease in human populations arises from exposure of people to infectious agents (viruses, bacteria and parasites) in sources of drinking water. Provision of safe drinking water is, therefore, an important development objective and adopting measures to ensure such provision and implementing these will have significant benefits for people.

The diseases and contaminants in drinking water can arise in a number of ways. However, one is through the discharge of untreated, or poorly treated, waste water from domestic sources whereby disease is spread within a population. Furthermore, discharge of untreated waste water can result in exposure through other routes, such as contamination of waters where bathing occurs.

The diseases associated with poor drinking water and poor waste water treatment overlap and, therefore, prevalence of such diseases in populations may reflect both exposure routes. As a result, the benefits arising from adopting and implementing measures to tackle these also overlap. Therefore, the assessment of benefits arising from improved drinking water and waste water treatment overlap. Therefore, the benefits arising from improved drinking water quality and waste water connection are addressed together in this analysis, followed by consideration of benefits arising from improved waste water treatment.

However, it is also important to note that improved waste water treatment has other benefits. Most notably, these include the reduction of nutrients and other contaminants that cause adverse changes to the ecology of surface waters. The benefits of improving the wider quality of surface waters are addressed separately.

This first section, therefore, focuses on the benefits of improvements in three household water, sanitation and hygiene parameters:

- connection to a reliable and safe piped drinking water supply on premises;
- connection to a sewage network; and
- improved domestic and personal hygiene practices whenever such practices are inadequate for health protection.

The section specifies a set of targets for the three parameters to be achieved by 2020. Improvements resulting from reaching the targets are estimated at the national level, benefits of these improvements are discussed qualitatively, with some benefits also assessed in quantitative terms. The quantitative assessment of the three water, sanitation and hygiene parameters is undertaken jointly as many households will benefit from improvement in more than one parameter.

Piped water supply to premises (yard/dwelling) and connection to a sewage network are generally the best opportunity to provide households with reliable and safe drinking water and to ensure safe and hygienic removal of human excreta and other wastewater pollutants from the household and community environment.

Piped water supply from a central water intake and distribution outlet allows for treatment of water and monitoring of water quality. If the water source is generally of good quality and the piped distribution networks are functioning well, such a water supply system can provide safe drinking water with minimal risk of disease.

Good hygiene practices are of utmost importance for disease prevention. The single most important hygiene practice is hand washing with soap at critical junctures (after defecation/going to toilet or cleaning a child faeces, before cooking and eating, and before feeding a child), found in many countries to reduce incidence of diarrhoea by as much as 45 per cent (Curtis and Cairncross 2003; Fewtrell et al 2005).

4.2.2 Current status in the region

The degree of provision of drinking water supplies to populations in the countries of the region varies (Table 4.1). In all cases provision is greatest for urban than rural populations. For urban populations, the highest levels of provision are found in Armenia and Belarus and the lowest in Azerbaijan and Moldova. For rural areas the variation between countries is much more significant. In Armenia and Belarus over 70% of rural populations have access to piped water supplies, but this is between 20 and 25% in Azerbaijan and Ukraine. Much of the rural population of these countries is provided with other improved water sources.

Provision of drinking water supplies (24 hours a day) is a first step. This water is still required to be of high quality to avoid illness. The level of treatment facilities varies, but most concern arises from the highly distributed supplies in rural areas which are less likely to be rigorously treated compared to centralised large urban supplies. This is illustrated for Russia in the following Box.

Box 4.1 The challenge of meeting drinking water standards in Russia

The provision of safe drinking water to urban and rural populations in Russia is a major challenge. Whereas 92% of urban populations are provided with a centralised piped water supply, this applies to only 40% of rural populations, which otherwise depend on autonomous water sources. Rural populations predominantly use groundwater sources (80-85% of all water used).

In 2009 20.4% of the water supplies of rural populations did not meet the national sanitary standards. This is due to a number of factors, including weak protection of aquifers from surface contamination, lack of sanitary protection zones and lack of timely repairs of supply pipes and treatment.

Understanding the extent of the problem is also a challenge. In 2009 authorities sampled the quality of drinking water in 65,709 settlements. While this is a significant number, it represents only 46.8% of the total number of settlements. Therefore, obtaining good data not only for determining the problem, but also for analysis of the benefits of addressing that problem is a challenge.

Table 4.1 provides an overview of the level of connection to the sewage network for each country in the region. In some urban areas this can be relatively high (but not complete), but many countries still have significant proportions of the urban population without connection, although these are general subject to other forms of improved sanitation. However, for rural populations the degree of connection to sewage networks is much lower and there are significant proportions of the rural populations of Armenia, Azerbaijan, Moldova, Russia and Ukraine without access to any form of improved sanitation.

Table 4.1 Household access to drinking water and sanitation for each country in the region. All figures are as percentage of the population for 2008.

	Armenia			**Azerbaijan**			**Belarus**			**Georgia**			**Moldova**			**Russia**			**Ukraine**		
	Urban	Rural	Total	U.	R.	T.	U.	R.	T.	U.	R.	T.	U.	R.	T.	U.	R.	T.	U.	R.	T.
Drinking water																					
Piped water on premises	97	70	87	78	20	50	95	72	89	92	51	73	79	13	40	92	40	78	87	25	67
Other improved water sources	1	23	9	10	51	30	5	27	11	8	45	25	17	72	50	6	49	18	11	72	31
Unimproved water sources	2	7	4	12	29	20	0	1	0	0	4	2	4	15	10	2	11	4	2	3	2
Sanitation																					
Toilet connected to sewage network	92	17	65	62	2	33	79	38	68	78	4	43	63	3	28	-	-	65	68	6	48
Other improved sanitation	3	63	25	21	68	45	12	59	25	18	89	52	22	71	51	-	-	22	29	84	47
Unimproved sanitation	5	20	10	17	30	22	9	3	7	4	7	5	15	26	21	7	30	13	3	10	5
Of which open defecation	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0

4.2.3 Potential environmental improvements

Targets to be reached by 2020

In order to determine the benefits of improved drinking water and waste water connection, it is necessary to identify targets for these services so that the benefits that would arise from meeting these targets can be compared with the current situation. The targets for which benefits are assessed in this study are:

Drinking water:

- Achieving 100% population connection (except in isolated rural areas) to reliable and safe piped water supply at household premises.
- Ensuring that the population currently having piped water supply continuously receives reliable and safe water at household premises.
- Providing plentiful and equally safe drinking water from other improved water sources in isolated rural areas.

Sewage connection:

- Achieving 100% population connection (except in isolated rural areas) to a sewage network system.
- Upgrading to flush toilet (with sewage connection) for households with dry toilet or no toilet).
- Providing improved sanitation to households currently without such facilities in isolated rural areas.

Hygiene:

- Improving hygiene practices especially ensuring good hand-washing with soap at critical junctures wherever such practices are currently inadequate for protection of health.

While piped water supply and connection to a sewage network have many advantages, these systems are, however, not necessarily problem-free. Piped water can become contaminated in the distribution network before reaching the household, and sewage may seep into the environment from leaky and broken network pipes. Thus, in order to achieve the targets, existing piped water and sewage networks may need rehabilitation to minimize water supply contamination and cross-contamination from sewage networks. Proper functioning also requires continuous appropriate pressure in existing and new piped water networks for a reliable supply of water.

Even in countries with relatively high coverage of the population with piped water supply and a central sewage system, such as in Georgia, the water supply challenges can remain significant. Factors that impact negatively on the quality of drinking water and reliability of the overall water supply system include pollution (with untreated waste water) of surface water sources, worn out and badly maintained distribution systems (with leaks and regular breakdowns) and inappropriate water treatment. The quality of the drinking water is problematic in particular in larger cities which take their water largely from polluted surface water sources. While tap water is often of inadequate quality, the situation is even worse for the population which is not serviced through a centralized drinking water system, in particular in some rural areas, and which consumes water from wells. Such water is usually not treated and often contains a high number of chemical and biological contaminants. The situation is worsened by the fact that water quality monitoring is often limited, both in the number of controls and of parameters. As such, public health and welfare is not ensured in several regions, with regular outbreaks of water related diseases, such as hepatitis, shigellosis and diarrhea.Information on the status of hygiene practices is generally not available in most countries unless detailed studies/surveys have been undertaken. What is clear, however, is that substantial improvements in hygiene practices can be achieved in most countries in the world. As the status of hygiene practices is not well known in the countries, the assessment in this study provides a benefit range for achieving the targets that, at the lower end, reflect the assumption that hygiene practices are generally adequate for protection of health and at the higher end reflect the assumption that practices can be substantially improved. In reality, benefits may be expected to be somewhere in between these two.

To estimate the number of beneficiaries and benefits of achieving the targets, the targets are compared to the percentage of the population currently equipped with piped water supply on premises, connection to a sewage network system, and good hygiene practices adequate for health protection. As hygiene practices are not well known, a range of 0-100 per cent is applied. Other baseline data are presented in Table 4.2. These data represent projections or a business-as-usual scenario as if no water, sanitation and hygiene interventions were undertaken to reach the targets.

Baseline assumptions:

- Birth rates are projected to decline by the percentages shown in the table (between 12 and 27 per cent).
- The diarrheal child mortality rate and diarrheal incidence rates are assumed to be constant.
- The child mortality rate from other infectious diseases is projected to decline by between 1 and 2 per cent per year.
- Average household size is assumed constant over the period to 2020.

Table 4.2 Baseline assumptions for each country.

Country	Birth rates	Mortality rate by diarrhoea among children	Child mortality rate from other infectious diseases (per year)	Average household size up to 2020
Armenia	Increase by 18%	Constant	Decline by 1.5%	Constant
Azerbaijan	Increase by 12%	Constant	Decline by 2%	Constant
Belarus	Increase by 26%	Constant	Decline by 1%	Constant
Georgia	Increase by 16%	Constant	Decline by 1.5%	Constant
Moldova	Increase by 14%	Constant	Decline by 1%	Constant
Russia	Increase by 16%	Constant	Decline by 1%	Constant
Ukraine	Increase by 27%	Constant	Decline by 1%	Constant

Improvements achieved by reaching the targets

The improvements from reaching the targets by 2020 are the difference between the specified targets and the baseline assumptions.

Improvements include:

- Across the region an additional 53.58 million people (19.9 million households) would have reliable and safe piped water to premises, and an additional 1.9 million people (0.3 million households) would have connection to a sewage network system (Table 4.3).
- As some rural communities may be too isolated to have these services provided, an unspecified but relatively small number of these people would be provided plentiful and equally good quality water from other improved water sources and improved sanitation facilities if currently without such facilities.
- Potentially a large share of the population that already has piped water to premises would benefit from improvements in reliability and quality of water (so as to have safe water on premises) by improved central water treatment and rehabilitation and upgrading of existing water distribution networks.
- Depending on current hygiene practices, potential beneficiaries of hygiene promotion range from 0 – 155 million people (0 – 58 million households).

Table 4.3 The number of people and households in the region that would benefits from meeting the targets for improved supply of drinking water and connection to a sewage network.

	Reliable and safe piped water supply to premises		**Improvement in reliability and quality of water among those currently with piped water supply**		**Connection to sewage network**		**Improved hygiene practices**	
	Number of people (million)	Number of households (million)	Number of people (million)	Number of households (million)	Number of people (million)	Number of households (million)	Number of people (million)	Number of households (million)
Armenia	0.41	0.11	0-2.74	0-0.72	1.10	0.29	0-3.15	0-0.83
Azerbaijan	4.9	1.2	0-4.9	0-1.2	6.6	1.6	0-9.8	0-2.4
Belarus	1.0	0.4	0-8.2	0-3.1	3.0	1.1	0-9.2	0-3.5
Georgia	1.07	0.29	0-2.9	0-0.8	2.26	0.62	0-3.97	0-1.09
Moldova	2.0	0.7	0-1.4	0-0.5	2.4	0.9	0-3.4	0-1.2
Russia	30	11.5	0-106	0-40.5	48	18	0-136	0-52
Ukraine	14.2	5.7	0-28.9	0-11.5	22.4	9.0	0-43.1	0-17.2
TOTAL	53.58	19.9	0-155.04	0-58.32	85.76	31.51	0-208.62	0-78.22

4.2.4 Benefits of improving drinking water quality, sewage connection and hygiene – qualitative assessment

Provision of reliable and safe piped drinking water, connection to a sewage network system (and flush toilet for those with dry toilet or no toilet), and practice of good hygiene (personal, household and community) have many benefits including health, environmental, economic and social benefits. A generic overview of these benefits is provided in Table 4.4. Some of these benefits (environmental, recreational, improved water resources) are discussed in the sections on Wastewater Treatment, Surface Water Quality, and Water Scarcity).

<table>
<tr><th colspan="3">Table 4.4 Benefits of improved potable water supply, sanitation and hygiene practices</th></tr>
<tr><th></th><th>Good quality piped water supply</th><th>Connection to a sewage network system (and flush toilet for those with dry toilet or no toilet)</th></tr>
<tr><td>Health benefits</td><td colspan="2">Good quality piped water supply, hygienic sanitation (flush toilets connected to sewage network) and good hygiene practices reduce the presence and transmission of pathogens, thus reduce the incidence of diarrhoea and other diseases (Fewtrell et al, 2005).

Reduced incidence of diarrhoea in early childhood contributes to improved nutritional status among children (World Bank, 2008).

Good hygiene practices (especially regular hand washing with soap) also reduce transmission of respiratory infections (Rabie and Curtis, 2006; Luby et al, 2005).

Reduced chemical, heavy metal, and other toxic substances contamination of drinking water reduce the incidence of associated diseases and health disorders.</td></tr>
<tr><td>Environmental benefits</td><td>Piped water connection and improved piped water quality do not lead to direct environmental benefits.

However, some benefits to habitats and water resources may accrue if water utilities press for protection or restoration of water quality of raw water abstraction sources.</td><td>Sewage collection provides opportunity for proper treatment of wastewater which helps improve environmental quality including cleaner communities, cleaner urban and rural waterways (e.g., canals), cleaner rivers, lakes and coastal waters, and reduced pollution of land resources (see sections on Wastewater Treatment and Surface Water Quality).</td></tr>
<tr><td>Economic benefits</td><td>Piped water connection with reliable and continuous good quality water reduces/ eliminates the need for:
– household water storage tanks
– spending time and money on household point-of-use treatment/ disinfection of water prior to drinking or on purchase of bottled water.

Good quality piped drinking water also:</td><td>The environmental benefits (see above) of sewage collection and proper treatment of wastewater can provide substantial recreational, tourism, and fishery benefits.

Good treatment of wastewater can also:
– allows for wastewater reuse in agriculture
– provides substantial cost savings in</td></tr>
</table>

Table 4.4 Benefits of improved potable water supply, sanitation and hygiene practices		
	Good quality piped water supply	**Connection to a sewage network system (and flush toilet for those with dry toilet or no toilet)**
	– reduces public and private health care expenditure – improves labour productivity and reduces work absenteeism. Access to good quality water can also provide cost savings to industries and make them more competitive, especially those relating to the food and beverage processing. Rehabilitation of existing piped water distribution networks (to improve water quality) reduces water losses and thus costs of providing potable water.	mobilizing and treating potable water, especially important in water scarce countries (see section on Water Scarcity).
Social benefits	Piped water connection with reliable and continuous good quality water supply provides increased convenience from having potable water available at premises. Access to good quality piped water also improves the public's perceptions of utilities and the state providing good quality services.	Sewage connection (and hygienic toilet on premises for those currently without it) – increases household convenience (no needs for emptying and maintaining sewage pits/septic tanks; reduced access time to toilet facility or place of defecation), – and reduces odours and nuisance from preventing direct sewage discharge into the local environment.

4.2.5 Benefits of improving drinking water quality, sewage connection and hygiene – quantitative assessment

As many of the benefits of reliable and safe piped water supply and connection to a sewage network are difficult to quantify, the assessment in this study is limited to:

- reduced incidence of diarrheal disease,
- reduced mortality from diarrheal disease, and
- reduced mortality from infectious diseases associated with improved nutritional status in young children from reduced incidence of diarrhoea.

Tables 4.5 and 4.6 presents the expected reduction in annual incidence of diarrheal disease and diarrheal mortality from reaching the targets, distinguished by population groups in relation to their current status of water supply, sanitation status (i.e. sewage connection), and hygiene practices. Among young children, these diarrheal disease reductions are expected to somewhat improve their nutritional status and thus reduce the risk of fatality from infectious diseases.[19]

Some clarification of these expected disease and mortality reductions are warranted. While groups 1-2 currently have piped drinking water supply, some households are likely to have sub-optimal water quality when connected to old, leaky networks and/or networks with fluctuating pressure and irregular continuity of supply, as water will be susceptible to contamination along the water distribution network even if water is well treated at central treatment plants. A 15% reduction in diarrheal disease and mortality is therefore expected on average for these population groups from improved reliability and quality of piped water. For population groups 3-4, which currently do not have piped water supply, a 25% reduction in disease and mortality is expected from receiving reliable and safe piped water supply to premises and in greater quantities than from their current water sources. Connection to sewage network (and flush toilets for those currently without such toilets) for groups 2 and 4 reduces the risk of pathogen transmission and is expected to reduce disease and mortality by an incremental 20%. If there also is substantial scope for improvement in hygiene practices among any of these population groups, disease and mortality reduction is expected to be an additional 30%.[20]

Based on the current distribution of population water and sanitation coverage, reaching the targets is estimated to reduce diarrheal disease and diarrheal mortality nationwide by 45% if the entire population has good hygiene practices adequate for health protection, and 75% if hygiene practices can generally be substantially improved. In actuality, disease and mortality reduction likely falls somewhere in between these two values, depending on current hygiene practices.

Table 4.5 Current water supply and sanitation coverage and Population distribution 2008

	Piped water supply and sewage connection	Piped water supply but no sewage connection	Not piped water supply but sewage connection	Not piped water supply and no sewage connection
Armenia	64%	23%	1%	12%
Azerbaijan	30%	20%	3%	47%
Belarus	67%	22%	1%	10%
Georgia	42%	31%	1%	26%
Moldova	25%	15%	3%	57%
Russia	63%	15%	2%	20%
Ukraine	47%	20%	1%	32%

19 See World Bank (2008) for a discussion and quantitative assessment of the nutritional impacts and associated health outcomes of repeated diarrheal infections in young children.

20 The expected diarrheal disease and mortality reductions are based on adaptations of findings reported in Arnold and Colford (2007), Clasen et al (2007), Fewtrell et al (2005), and Curtis and Cairncross (2003).

Table 4.6 Water and sanitation improvement: expected average reduction in diarrheal disease and mortality

	Improvement in reliability and quality of piped water (so as to ensure plentiful and safe water supply) for those of this population currently having water reliability and quality problems		a) Improvement in reliability and quality of piped water (so as to ensure plentiful and safe water supply) for those of this population currently having water reliability and quality problems. b) Sewage connection (and flush toilet for those with dry toilet or no toilet) for all of this population.		Reliable and safe piped water supply to premises for all of this population		Reliable and safe piped water supply and sewage connection (and flush toilet for those with dry toilet or no toilet) for all of this population	
	Already good hygiene	***Substantial scope for hygiene improvement***	***Already good hygiene***	***Substantial scope for hygiene improvement***	***Already good hygiene***	***Substantial scope for hygiene improvement***	***Already good hygiene***	***Substantial scope for hygiene improvement***
Armenia	15%	45%	35%	65%	25%	55%	45%	75%
Azerbaijan	15%	45%	35%	65%	25%	55%	45%	75%
Belarus	15%	45%	35%	65%	25%	55%	45%	75%
Georgia	15%	45%	35%	65%	25%	55%	45%	75%
Moldova	15%	45%	35%	65%	25%	55%	45%	75%
Russia	15%	45%	35%	65%	25%	55%	45%	75%
Ukraine	15%	45%	35%	65%	25%	55%	45%	75%

4.2.6 Benefits of improving drinking water quality, sewage connection and hygiene – monetary assessment

The data on the benefits arising from improved drinking water and sewage connection, together with information of the prevalence of disease, can be used to estimate the number of cases of diarrhoea that would be avoided from improved drinking water quality and sewage connection and the number of deaths avoided from such disease. These results are presented in Table 4.7. It is important to note that lack of information on hygiene practices means that such estimates have to be presented as a high and low estimate based on the potential variation in how well such practices are implemented. Overall, across the region, the benefits that would accrue from improved drinking water quality and sewage connection would be between 31 million and 66 million annual cases of diarrhoea avoided and between 832 and 1,674 deaths avoided. These would be significant benefits.

Using the benefits methodology accompanying this report these instances of disease (morbidity) and deaths (mortality) can be monetised. Overall, across the region, the annual monetised benefits that would accrue from improved drinking water quality and sewage connection would be between €4,772 million and €10,376 million for morbidity, between €836 million and €1,740 million for morbidity, which would give total annual benefits of between €5,607 and €12,115. These are large benefits and across the countries in the region would represent between 0.14% and 1.08% of the GDP of individual countries.

This approaches on the issue of avoided risk of real impacts. There is also the issue of public confidence as well as public expenditure related to lack of confidence in water quality. For example, despite high connection levels of water supply and to a sewage network 55 per cent of the Ukrainian population treats their water prior to drinking with what may be considered appropriate treatment methods (e.g., boiling, filtering, chlorination) according to the Ukraine MICS 2005 survey. Provision of reliable and safe piped water would reduce the need for such household treatment prior to drinking and the purchase of bottled water. In some benefits studies the consumer wellbeing associated with the increased confidence is assessed (e.g. Ecotec et al., 2001) and in other studies the costs of substitute products has been looked at. These would both give important economic estimates of the value of clean (quality, colour and smell) water supply. The approach in this study has been to focus primarily on the concrete issue of health impacts avoided and should therefore be seen as an conservative estimate of value (though some aspects of consumer preference is picked up in other aspects of the water chapter and the team wished to avoid double counting).

Table 4.7 Estimated annual benefits in 2020 of meeting the water, sanitation and hygiene targets

Note: 'Low' represents cases avoided and costs if the population already has good hygiene practices adequate for health protection. 'High' represents cases avoided and costs if population hygiene practices can generally be substantially improved.

	Annual cases avoided				Annual monetized benefits (Million € (PPP))							
	Diarrhoea		Deaths		Morbidity		Mortality		Total		Total (% GDP)	
	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low
Armenia	1,221,079	541,981	34	15	68	30	16	7	84	37	0.43%	0.19%
Azerbaijan	4,630,669	2,454,180	829	439	374	198	566	300	939	498	1.08%	0.57%
Belarus	2,652,150	1,154,634	14	6	300	131	13	6	313	136	0.27%	0.12%
Georgia	1,602,971	796,662	77	38	72	36	29	14	101	50	0.51%	0.25%
Moldova	1,191,566	648,074	31	17	33	18	7	4	40	22	0.39%	0.21%
Russia	40,878,986	18,534,082	577	262	8,593	3,896	1,046	474	9,639	4,370	0.32%	0.14%
Ukraine	13,967,929	6,903,628	112	55	936	463	63	31	999	494	0.31%	0.16%
TOTAL	**66,145,350**	**31,033,241**	**1,647**	**832**	**10,376**	**4,772**	**1,740**	**836**	**12,115**	**5,607**	**-**	**-**

4.3 Level of waste water treatment

4.3.1 Introduction

Waste water once collected (see previous section on sewage connection) still presents significant problems for health and ecosystems if it is not subject to appropriate levels of treatment. The level of waste water treatment is often rather poor and there is substantial room for improvement in many of the countries under study, or in parts of them (see an example for Armenia in the box below). Poor waste water treatment leads to damage to the natural environment and can substantially affect water quality. Health impacts are discussed under the parameter 'Connection to sewage network and hygiene conditions' as they involve the same diseases.

The following definitions apply:

- *Urban waste water:* domestic waste water or the mixture of domestic waste water with industrial waste water and/or run-off rain water. (CEC, 1991)
- *Domestic waste water:* waste water from residential settlements and services which originates predominantly from the human metabolism and from household activities. (CEC, 1991)
- *Industrial waste water:* any waste water which is discharged from premises used for carrying on any trade or industry, other than domestic waste water and run-off rain water. (CEC, 1991)
- *Waste water treatment:* any process that reduces the amount of the suspended solids, and dissolved compounds and micro-organisms harmful to the environment and/or the human health in waste water. Only treatment in facilities operating with the approval of environmental and/or health authorities should be considered. (WHO 2002)
- *Primary treatment:* treatment of urban waste water by a physical and/or chemical process involving settlement of suspended solids, or other processes in which the BOD5 of the incoming waste water is reduced by at least 20 % before discharge and the total suspended solids of the incoming waste water are reduced by at least 50 %. (CEC, 1991)
- *Secondary treatment:* treatment of urban waste water by a process generally involving biological treatment with a secondary settlement or other process. (CEC, 1991)
- *Tertiary treatment:* The process which removes pollutants not adequately removed by secondary treatment, particularly nitrogen and phosphorus; accomplished by means of sand filters, microstraining, or other methods. (EEA, undated)
- *Eutrophication:* the enrichment of water by nutrients, especially compounds of nitrogen and/or phosphorus, causing an accelerated growth of algae and higher forms of plant life to produce an undesirable disturbance to the balance of organisms present in the water and to the quality of the water concerned. (CEC, 1991)

Box 4.2 The degraded infrastructure for waste water treatment in Armenia

Armenia has 20 waste water treatment plants. These were built before 1990 (i.e. during the Soviet period) and were only built to serve urban areas – there is no provision for waste water treatment in rural areas. However, currently only two of these 20 waste water treatment plants are operational. Furthermore, these waste water treatment plants were not built to meet any modern standards and effectively provide little more than primary treatment (not secondary or tertiary treatment). The treatment techniques in the waste water treatment plants were based on the expectation of extensive, cheap supplies of energy. This is no longer the case and the costs of the treatment have effectively prevented their operation in most cases.

As a result, much waste water is discharge untreated into surface waters with resulting impacts on ecosystems and health. Investment is needed to improve waste water treatment and delivering such investment is not helped by the fact that households are not subject to any tariff for waste water discharge which could form part of a revenue raising process. However, three waste water treatment plants are being constructed near to Lake Sevan and the waste water treatment plant in Yerevan is to be subject to partial reconstruction.

4.3.2 Benefits of improving waste water treatment – qualitative assessment

The benefits of improved waste water treatment include health benefits and wider ecosystem benefits. These are addressed in more detail in the preceding and following sections respectively. These benefits also have economic and social benefits. This full range of benefits is summarised in Table 4.8.

Table 4.8 Overview of key benefits of improved waste water treatment

Health benefits	Most health benefits are related to sewage collection, rather than treatment per se, as sewage that is not appropriately collected can cause significant health problems (such as diarrheal diseases, dysentery etc.). These benefits are therefore assessed under the 'sewage connection' parameter and not here, to avoid duplication.
Environmental benefits	The increased and improved treatment of wastewater is meant to lead to a reduction in nutrient discharges and, therefore, a reduction in eutrophication in aquatic ecosystems, with due improvements to the ecosystems and associated recovery of fish and other aquatic life. It must be noted that nutrient removal does not just arise from tertiary treatment. Significant removal also occurs with secondary treatment. Where eutrophication represents an important ecologic problem (e.g. Ukraine), the environmental benefits can be significant.
Economic benefits	Many drinking water sources are derived from rivers, which receive wastewater discharges. Therefore a reduction in contaminants in the abstracted waters can bring direct financial benefits in terms of reduced costs of treatment for potable water. Moreover it can be anticipated that, thanks to increased/improved water treatment, surface water should be more suitable for economic uses such as cooling water and industrial water. This will bring significant direct cost reductions to water intensive industries in particular. Furthermore, the investment in environmental technology and improvement in the skills of those working in the water industry will assist in enhancing the economic base of the country.

Table 4.8 Overview of key benefits of improved waste water treatment	
Social benefits	Most health benefits are related to sewage collection, rather than treatment per se, such as nuisance related to odours from direct discharge of sewage in the environment etc. These benefits are therefore assessed under the 'sewage connection' parameter and not here, to avoid duplication.

4.3.3 Benefits of improving waste water treatment – quantitative and monetary assessment

The health benefits from improved waste water treatment accrue jointly with improved sanitation. The joint assessment is provided in the preceding section.

Box 4.3 Connection to safe drinking water, connection to sewage network, and level of waste water treatment in Azerbaijan

The water supply system for the town of Aghsu in Azerbaijan is old, poorly maintained and largely inoperative. The town lacks a public water supply 2-4 months a year, during which time water is obtained from tanker trucks. In a recent public survey in Aghsu, over 95% of respondents reported poor water quality, 80% reported no public water supply at all, and 25% of those with supply reported frequent interruptions. Additionally, there is no domestic wastewater collection network in Aghsu: most domestic wastewater is discharged from outdoor toilets into simple pits or, more rarely, lined septic pits. There is considerable cross-contamination of the wastewater and water supply systems, with seepage from septic tanks and unlined ditches contaminating aquifers and wells throughout the town.

A proposed project would establish a new water collection and distribution system, which would collect water from springs in nearby hills and pipe water under gravity to the town of Aghsu. The construction of this new water source and distribution infrastructure will deliver water to WHO, EU and Azeri water quality standards, meeting all forecasted demand through a 2030 planning horizon. A new sewer collection system is also proposed, using approximately 79 km of piping and relying on gravity for much of the collection flow. In addition, a new wastewater treatment plant will be constructed to handle all the waste from the community.

If one took a financial analysis perspective alone, the water supply and wastewater collection/treatment project would have a negative NPV. However, by adding in monetized environmental and social benefits, a more comprehensive valuation approach demonstrates the considerable additional societal value that these projects provide, including:

- a willingness-to-pay societal value of €22 million
- potential job preservation benefits of at least €1 million;
- and estimated health benefits potentially exceeding €100 million.

4.4 Surface Water Quality

4.4.1 Introduction

The surface water quality parameter measures the benefits derived from improvements in the level of quality status of rivers, lakes, reservoirs, transitional and coastal waters (up to three nautical miles) for each East ENPI country and the Russian Federation. This section reports on the assessment of the health, social, environmental and economic benefits to society derived from the achievement of a given policy target for surface water quality improvements by 2020. The benefits are analysed in two ways: qualitatively and, where available information allows it, monetarily, through an economic valuation of the benefits. The aim of the economic valuation exercise is to estimate the economic value of uses people in the country would make of surface water that meets the policy target by estimating what local residents would be willing to pay for the changes. The approach to valuing improvements in surface water follows that of a UK study which determined the willingness to pay of households for cleaner water. The original benefit functions of this study have been adapted and transferred to each of the East ENPI countries and the Russian Federation. Thus, allowing for the inclusion of specific contextual water quality and socio-economic information in the benefits transfer exercise.

4.4.2 Current status in the region

The main problems related to surface water quality in East ENPI countries and the Russian Federation are concerned with low water quality levels due to the lack of infrastructures for clean water supply and waste water treatment (this is especially a serious issue in rural areas).

In terms of water quality, the discharge of waste water without adequate treatment is a problem affecting surface waters, with organic pollution occurring in most major rivers. High concentrations of heavy metals, BOD, COD are identified in surface waters. Although the lack of monitoring stations, and sometimes also lack of, or inadequacy of, national quality standards for substances, makes it impossible for most countries to assess the present pollution situation of their rivers, lakes and reservoirs.

In most countries, water is being used mainly for irrigation (e.g. 66% in Armenia), followed by municipal use and any use is potentially affect by poor quality of the waters from which those uses are sourced. Unauthorised, spontaneously created landfills are also causing pollution of surface water, since often the household wastes are dumped on the banks of rivers. In Ukraine, the Chernobyl' accident added to the pollution of surface water bodies, foremost the catchments of the basins of the Prypiat and Dnipro rivers.

4.4.3 Benefits of improving surface water quality – qualitative assessment

Water quality influences human uses of the affected resources, leading to changes in use values and non-use values of the resource. It is difficult however, to quantify the relationship between improvements in water quality and the improvements in societal well-being that are not associated with direct use of the affected resource. That these values exist, however, is indisputable, as evidenced, for example, by society's willingness to contribute to nature conservation organisations. Given that not all benefits can be quantified, it is important qualitatively to describe all benefits that can be derived from improvements in water quality, including those that cannot be quantified.

An overview of key benefits derived from improved surface water quality in East ENPI countries and the Russian Federation can be found below. The overview reflects the range of goods and services that are provided to society by a healthy water environment. Please note that some of these benefits have been covered under other sections of this report.

Table 4.9 Overview of key benefits of improved surface water quality	
Health benefits	- Polluted water is a major cause of human disease and death. The key diseases avoided are those of the alimentary system. Microbial (both bacterial and viral) contaminants (e.g. E-coli) can cause a range of problems from mild disorders to major diseases such as dysentery. Some diseases will occur from infection by regularly occurring intestinal bacteria, while others are diseases passed on from those already infected. - Treatment to remove common bacteria (such as faecal coliforms) will also destroy a wide range of bacteria that cause more dangerous, if infrequent, infectious diseases.
Environmental benefits	- Excessive nitrate concentrations can cause extensive harm to the environment through eutrophication. Nitrates greatly stimulate the growth of algae. The decomposition of such algae reduces the water's dissolved oxygen content, adversely affecting fish and other aquatic life. Decreases in nutrient loadings thus benefit aquatic habitats. This, accompanied by lower sediment and pesticide loadings, results in increased fish and waterfowl populations. - The presence of pollutants/toxic substances in water (e.g., metals, pesticides), affect a wide range of animal, fish and vegetation: o Species may be affected by direct toxic effects on metabolism and the disruption of endocrine functions, which often impacts on the reproductive system. o Some substances can also accumulate both within the environment (e.g., sediments) and within animals (bioaccumulation). Therefore they can represent a significant threat even in small concentrations. - Physical effects translate into biological impact, i.e. ecosystem damage and biodiversity loss.
Economic benefits	- Cleaner surface water resources can: o reduce costs to industry (e.g. for pre-treatment). o reduce costs to society by avoiding the escalation of the cost of remediation and of drinking water treatment. o stimulate the development of new environmental technologies (e.g.

Table 4.9 Overview of key benefits of improved surface water quality	
	for water treatment). o avoid microbiological contamination of food crops. o increase fish populations and catch. o enhance the potential for tourism, such as on the Black Sea coast. o increase the value of property. - Water pollution is both a cause and an effect of linkages between agriculture (the single largest user of freshwater on a global basis) and human health: o Agriculture is a major cause of degradation of surface and groundwater resources through erosion and chemical runoff. Measures to reduce the negative impact of agriculture can lead to improved farm practices and reduced costs. o Avoiding microbiological contamination of food crops, stemming from the use of water polluted by human wastes and runoff from grazing areas and stockyards. This applies both to use of polluted water for irrigation, and by direct contamination of foods by washing vegetables etc. in polluted water prior to sale. Crops that are most implicated with spread of these diseases are ground crops that are eaten raw. - Increased fish stocks and harvest: reducing pollution is expected to enhance aquatic ecosystem habitat and thus to greatly contribute to increasing freshwater fish populations. These population increases would positively affect subsistence anglers, commercial anglers and fish sellers, and consumers of fish and fish products. - Aesthetic degradation of land and water resources resulting from pollutant discharges can reduce the market value of property and thus affect the financial status of property owners.
Social benefits	- Water pollution affects the quality of living in the areas nearby surface waters. - Improved surface water quality will favour recreational uses, such as swimming, boating and angling. Improved water appearance and odour make it more desirable and visually appealing for recreation. - Pollutants can also have effects on health (see above) and therefore can place a strain on social support systems within a community and lead to a feeling of isolation of that community from the social structure of the country as a whole. - Even if no human activities are affected by water quality degradation, such degradation may still affect social welfare. For a variety of reasons, including bequest, altruism, and existence motivations, individuals may value the knowledge that water quality is being maintained, that ecosystems are being protected, and that populations of individual species are healthy completely independent of their use value.

4.4.4 Benefits of improving surface water quality – quantitative and monetary assessment

In order to achieve the aforementioned benefits, some ENPI countries have already defined their own surface water quality targets and are organising themselves in order to reach the objectives somewhere between now and 2020 (which is the target year for this study) or beyond. Some countries are understood to be even aiming to match targets of EU water policy, such as the achievement of Good Ecological Status (GES) for all surface waters.

In this study, for the transfer of benefits functions we do not consider changes in water quality management policy between now and the fixed period in 2020 but assume that existing policy is driven by the EU Water Framework Directive and the objective of no deterioration in quality and achievement of GES. The baseline scenario is the current water quality levels in the countries.

The benefits function transfer (BFT) approach from the UK study can be applied as long as we know the percentage of freshwater units (river length or surface area for lakes) that would fall into each water quality category as used in the original valuation study. Moldova is highlighted below to illustrate an example of the type of baseline information that has been used to feed the BFT models.

Box 4.4 Case examples: Moldova and Georgia

Baseline water quality levels in Moldova

The baseline water quality information used from Moldova to feed the benefits transfer model indicates that presently 100% of the catchment area of rivers and lakes in the country would fail to achieve good ecological status according to the WFD. The river network in the country accounts for a total length of 1,891 Km. According to national water quality classification 1352 km (Nistru and Prut) – Use Class II-III categories and 539 km (small rivers) – Use class IV-V. 100% of the lakes are in use class III. Under this class simple treatment methods no longer suffice for drinking water preparation and the minimum condition required by salmonid fish waters may no longer by supported. Ultimately, no rivers or lakes can be found in Moldova in the Use Class I (which would be the equivalent to the WFD's 'good status') corresponding to a little disturbed, near natural aquatic system. For further information (including descriptions on class status categories) please see the specific country report for Moldova.

Benefits of improving water quality and infrastructures in Georgia

The health, environmental and economic benefits would be significant: Georgia depends on a healthy Mtkvari river for industry, agriculture, fishing, energy production and recreation. For example, large areas of eastern Georgia depend on agriculture irrigated by the Mtkvari. Also, some of Georgia's hydropower (which supplies approximately 80% of Georgia's electricity) comes from schemes on the Mtkvari. From a tourism perspective, the coastal bathing areas have a strong economic potential, but during the bathing season, the Black Sea coast beaches often have to be closed due to microbiological contamination. An improvement in quality of bathing waters (where this is currently poor or below standards) can ensure that more tourists are attracted to the area and thus revenues for the local economy are secured. Better water quality leads to increased fish populations and catch in the many lakes, but in particular also the Black Sea which is home to rare, endemic, and economically important species (e.g. valuable sturgeon species).

Unfortunately, the availability of the needed background information on river and lake water quality for the construction of the baselines to feed the BFT models varies from country to country. Countries for which nation-wide quality status assessments exist for rivers are: Ukraine, Moldova, Belarus, Azerbaijan and the Russian Federation.

For the remaining countries that do not have nation-wide assessments of water quality, baseline levels are assumed to be in the worst case scenario (100% improvement needed) or rely on expert opinion.

Furthermore, nation-wide assessments of lake water quality only exist for Moldova but without any information on their total surface area. Thus lake water quality has not been included in the BFT models and benefits have not been monetised. This highlights that further efforts need to be placed into monitoring current water quality conditions in these countries.

Further discussion on the constraints and detail of the model are provided in the Box below.

Table 4.10 illustrates the range of monetary benefits in East ENPI countries and the Russian Federation from an improvement in river quality from current conditions to Good Ecological Status (GES), which is the overarching environmental objective of the EU Water Framework Directive (WFD).

The monetary benefits are equal to the estimated amount of money that households in each country of the region would be willing to pay for improved surface water quality by 2020.

Table 4.10 Benefits of meeting water quality improvement targets – East ENPI countries and the Russian Federation, 2020

COUNTRY	**WTP results in 2020 € PPP per HH year**		**Aggregated benefits WTP in 2020 € PPP million**		**Benefits relative to GDP in 2020 %**	
	lower	upper	lower	upper	lower	upper
Armenia	45.9	180.4	38.1	149.7	0,20%	0,79%
Azerbaijan	30.7	143.3	92.1	430	0.11%	0.49%
Belarus	58.8	207.1	204	718	0.18%	0.62%
Georgia	44.5	174.6	48.5	190.3	0.25%	0.97%
Moldova	37,8	147,1	45.4	177.1	0,44%	1,73%
Russian Federation	67.1	229.8	3.51B	12.1B	0.11%	0.38%
Ukraine	50.5	184.6	870.1	3,180.5	0.27%	1.00%

Box 4.5 Further background to the use of the Benefits Function Transfer (BFT) in this analysis

Due to the lack of regional valuation studies on the topic, and the impracticability, due to the time and budget constraints of conducting an original valuation study, the BFT approach has been applied to estimate the total economic value of cleaner water. Unlike direct value transfer, this method allows for the incorporation of differing socio-economic and site quality characteristics between the original study site for which the original benefits estimates were obtained and the policy site under evaluation. Under this approach, typically only one original valuation study is selected. The main assumption made is that the statistical relationship between willingness-to-pay (WTP) values for improvements and independent variables are the same for both the study and policy site. In other words, the method assumes that preferences/tastes are the same for both locations and differences in WTP are only related to differences in socio-economic and/or environmental context variables.

The benefits from water quality improvements covered in this section by the application of the BFT method are related to the quantifiable portion of the total economic value of particular use and non-use types derived from the enjoyment of good water quality by local residents of the country. The specific types of water uses covered in the model are highlighted with examples in Table 4.11 below. It is important to note that it is not possible to disaggregate values for the different types of uses outlined below and that other types of water uses are valuated and assessed in other sections of this report.

Table 4.11 Types of benefits covered with the proposed method

	Types of water uses			Example
Potential Water Quality Benefits	Current use benefits	Direct use	In Stream	Recreational activities: Fishing, swimming, boating
		Indirect use	Near Stream	Recreational activities: Hiking, trekking
				Relaxation, enjoyment of peace and quiet
				Aesthetics, enjoyment of natural beauty
	Non Use		Option	Preferences for future personal use of the resource
			Existence	Maintaining a good environment for all to enjoy
			Bequest	Enjoyment from knowledge that future generations will be able to make use of the resource in the future

In order to transfer the benefit functions from Baker et al (2007), the following variables have been adjusted from the original model:

- Current fresh water quality levels (information collected in-country);
- Average income levels per household (World Bank);
- Education levels (World Bank);
- Population number, Household Gender composition and Household occupancy (World Bank);
- Other socio-economic stats: GDP figures in Euro and local currency, PPP conversion factors and projections (World Bank).

Due to the uncertainty around transferring values across quite different contexts, including the assumption that differences in WTP are only related to differences in socio-economic or environmental context variables, the findings should be treated as fairly rough estimates. Results are shown in a range to illustrate the degree of uncertainty associated with the benefits estimates. The following are important aspects to take into consideration when making use of the results reported above: 1) only people residents in these countries are considered. Any possible value that visitors to the country may put on the overall quality of water resources is not accounted for in this method; 2) values have not been separated by types of uses of water, use (e.g. recreation) and non-use values (e.g. those derived from the enjoyment of good water quality) are included in the analysis.; 3) the analysis illustrates a portion of the TEV of water quality improvements, only valuation of people's preferences for changes in quality are included here, other chapters in this synthesis report illustrate other types of values, including direct use market values; and 4) it has been assumed that all water bodies in each country have the same value. This assumption becomes important when considering that values for some water bodies may be higher if they are of significant importance (for example for cultural reasons) or if water resources are scarce. Values may also decrease when overall water quality in the country increases as a result of the improvements.

4.5 Water resource scarcity

The ability to secure a sustainable water supply is one of the greatest challenges facing society today. Attempting to create a balance between the needs of people and the pursuit to continue economic development has created a situation where water resources are increasingly at risk from drought, flooding, ageing infrastructure and water pollution.

4.5.1 Introduction

The concept of scarcity is considered relative, that is, the imbalance between supply and demand varies according to local conditions. However, water scarcity is fundamentally dynamic and intensifies with increasing demand and decreasing quantity and quality. There is often a trade-off needed to manage the water demands of various sectors including agriculture, industry and public use with the environment, which can be achieved through the development of an integrated resource water management plan. However, gains in one area may provide synergistic benefits in another, e.g. in Belarus, the benefits of improving water resource use and management will bring health benefits to agricultural based communities in times of drought, reduce crop and livestock loss and improving economic productivity.

The European Environment Agency (2009) measures stress on freshwater resources as the Water Exploitation Index (WEI). It is suggested that countries should, where appropriate, aim to lower their WEI towards 20-40%. A reduced WEI should allow more water to be available to maintain and enhance wetlands and water bodies with improved biodiversity and ecosystem services.

Diverse landscapes, changing climates and varied regional and national initiatives influence the type and level of response to the issue. The challenge of managing water scarcity is further complicated by economic and political instability and the requirement of sustainable partnerships between countries that share both political boundaries and resources (USAID, 2002) [21] (FIIA, 2010) [22].

4.5.2 Current status in the region

Water resources are distributed unevenly throughout the majority of the ENPI East region (across the regions, within the countries and across the year), with the most populated and economically important areas also those most vulnerable to water scarcity. Although several countries, including Belarus, Moldova and Russia, do not have water scarcity concerns at present nor predictions of scarcity in the near future, areas within each country and the region as a whole are already facing water shortages. Drought, flooding, ageing infrastructure and water pollution are critical problems that need to be addressed in order to support sustainable economic development in the region.

(21) USAID (2002) *Water Management in the South Caucasus* USAID Contract No. OUT-LAG-I-804-99-00017-00

(22) Finnish Institute of International Affairs (FIIA) (2010) *Managing Blue Gold New Perspectives on Water Security in the Levantine Middle East*

Box 4.6 water availability/scarcity: cases

Water is used within its availability in Ukraine, and with a total of 3,000 m^3 available per person per year, the country is not water stressed. Water scarcity therefore does not seem to be an issue. However, resources are unevenly distributed throughout the country. In the north and northwest they are sufficient, while the south (including the Crimea), where the bigger consumers are located, suffers water shortages and depends on water transfers. The Dnipro (Dnepr) River is the main source, supplying three quarters of Ukraine's fresh water, but is heavily polluted.

For Georgia, the quantity of renewable water resources is enough to meet present public and industrial demand for water in Georgia. **Water scarcity** therefore does not seem to be an issue. However, water resources are not equally distributed throughout the country. The inhabitants of the semiarid eastern regions of Georgia frequently suffer from severe water shortages, while the western regions are subject to flooding due to an overabundance of rainfall. The threat of climate change, with increasing temperatures contributing to desertification, could exacerbate this regional water shortage.

Key water scarcity statistics for the region are summarised in Table 4.12 below. However, it is important to note that these are aggregated data for countries as a whole. As highlighted above, within each country there may be considerable differences between localities, with some areas prone to floods whilst others are prone to droughts. Hence the average country level WEIs look good, but they mask underlying scarcity issues. Georgia, for instance, has an overall WEI of just 3%, suggesting ample water availability. However, water resources are not equally distributed with the semiarid eastern regions of Georgia frequently suffering from severe water shortages, while the western regions are subject to flooding due to an overabundance of rainfall. (UNECE EPR, 2010).

The region is prone to large annual variations in water availability with habitual and often severe flooding in lowland areas coupled with more frequent and widespread droughts in the arid and semi-arid regions. Loss of natural wetlands and human activities related to removal of forests and non-systematic grazing are further exacerbating flood-related problems. Georgia, for example, the threat of climate change, with increasing temperatures contributing to desertification, could exacerbate the regional water shortage (WWF, 2008). Despite the apparent abundance of water, until relatively recently Georgia had 2,560 km2 of wetlands, yet today it has been reduced to 627 km2 (draft SoE Report 2007-2009).

Water use significantly declined in parts of the region after the breakup of the Soviet Union due to conflicts, problems associated with land reform, transition to market economy and loss of traditional trading partners. These changes have led to reduced irrigation, but also a lack of investment to maintain and modernise infrastructure. Significant network losses, up to 60% in some areas - – for example, in Armenia - are common due to aging infrastructure and illegal connections, which has resulted in interrupted supply and lack of drinking water in some areas. High levels of water pollution are common in many water bodies due to lack of adequate wastewater treatment and run-off from commercial and industrial operations.

Table 4.12 Water Scarcity Statistics

Country	Total actual renewable water (TARWR)	Amount of surface water from neighbours	Total water use				Water exploitation index	Water available per capita	Total water use per capita	Municipal water use per capita
	km^3/year	%	Agriculture (%)	Municipal (%)	Industry (%)	Losses (%)	%	m3/person/ year	m3/person/ year	m3/person/ year
Armenia	0.0001	0%	66%	30%	4%	-	36%	2520	920	270
Azerbaijan	0.16	70%	77%	4%	19%	-	35%	3840	1410	60
Belarus	58	36%	30%	23%	47%	-	5%	5990	290	70
Georgia	63	13%	65%	22%	13%	-	3%	14700	380	80
Moldova	12	79%	4%	21%	68%	7%	20%	3210	640	60
Russia	4508	4%	20%	20%	60%	-	1%	31760	470	90
Ukraine	140	21%	53%	12%	35%	-	27%	3020	810	100
Average	***683***	***32%***	***45%***	***19%***	***35%***	-	***18%***	***9291***	***703***	***104***

Source: FAO or other sources, data taken from country reports (based on 2002 to 2008 data)

Reforms in integrated water resources management are underway across the region to varying degrees; however, those trying to implement or align to the EU Water Framework Directive (WFD) are experiencing difficulties. Low or non-existent tariffs are common and contribute towards unsustainable water use. With the exception of Azerbaijan and Moldova, each country is self-sufficient in terms of sourcing water from within their own borders and there is a significant mix in water use through-out the region with agriculture being the dominant sector in half of the countries and industrial uses in the remaining.

4.5.3 Benefits of reducing water scarcity – qualitative assessment

Reducing water scarcity and optimising overall water use across the region can have a multitude of environmental, economic, health and social benefits. However, due to the complexities of water management issues and budgetary constraints, this study was not able to evaluate the monetary benefits of improved water resource management in general. Instead, an overview of associated qualitative benefits is provided below, with a few selected examples indicating the potential magnitude of costs associated with floods and droughts.

Improvement of environmental flows within surface water bodies can increase water availability, which can help maintain and enhance a broad range of habitats and species within wetlands, rivers and lakes. Economic benefits from increased agricultural output can be realised through improved irrigation techniques and application of best practices. Greater water availability within the agricultural sector could also help reduce crop and livestock loss during periods of drought. Equally, restoration of natural ecosystems may help ease the burden of floods.

In times of drought, the health of poor agricultural based communities may improve if the amount of crops and livestock lost to drought is reduced. There could also be an improvement in health of local populations through better diets if there is an increase in fish and fishing in rivers and lakes, although other health problems could arise if the fish are contaminated.

Increased tourism and recreation can be achieved through better access to natural water bodies and this can also help preserve the cultural and spiritual benefits that are associated with some water bodies.

Box 4.7 The Cost of Droughts and Floods

A review of costs related to crop damage and loss from floods and drought can provide insight into assesses the monetary value of water scarcity through improved water resource management. Three examples that clearly demonstrate the cost of water resource issues in the region are summarised below; however, there is limited data available on this topic and these examples for should be used with caution.

- **Armenia:** Losses in agricultural production from severe drought are estimated to have cost €75m (USD110m) in 2000 and €27m (USD40m) in 2008 (Second National Communication on Climate Change, 2010).
- **Azerbaijan:** Flood damage costs approximately €12-17m (USD18-25m) annually (Second Azerbaijan National Communication to the UNFCC, 2010).
- **Moldova:** Catastrophic droughts in 2007 resulted in losses estimated to be worth nearly €680m (USD1bn).

Overall, assessing water scarcity and management issues is a complex task. This study has simply provided a high level overview of associated issues and benefits. It has also highlighted that although the national statistics may not show overall water scarcity, within each country there may be considerable differences between localities, with some areas prone to floods whilst others are prone to droughts. This analysis is limited by the lack of readily available data. The figures that are available are several years old, if not more, and projected growth for domestic, agriculture and industry water demand is not readily available making it difficult to accurately project future needs.

The diversity of water scarcity issues in the region presents additional challenges and pressures to consider when how best to manage the competing demands. Floods in some areas and droughts in others, as well as general problems with out-of-date infrastructure and water pollution, must all be taken into account. In terms of infrastructure, Ukraine is perhaps most advanced in this respect with close to 100 % of the population having domestic access to improved water sources and sanitation. With infrastructure established, the next step is to improve the quality of water sources and the related wastewater discharges by treatment and disinfection of both water supply and waste water. Tackling these issues in a holistic manner is essential, through consideration of both supply and demand issues. This is best achieved through developing integrated water resource management plans and promoting the creation of proactive strategies to help sustain levels of water use.

This research considers domestic water demand to increase as populations grow and consumer demands increase. Agricultural and industrial growth and water demands are also likely to increase significantly by 2020. However, these assumptions are complicated by issues such as potential changes related to an increased number of households connected to mains, reduced water use that may be achieved through new or higher tariffs, and increased awareness or improved infrastructure. In addition, climate change is likely to bring changes to temperatures and precipitation patterns, which could change the reliance on current systems such as irrigation, and should be explored in more depth.

Enhanced integrated water resource management and a better understanding of associated economic values to optimise overall economic, environmental and societal benefits is strongly recommended.

4.6 Conclusions – Water related benefits

Poor provision of drinking water quality, poor surface water quality, inadequate supplies of water and poor provision of waste water collection and treatment all present significant challenges to the countries of this region. In all cases, tackling these problems would deliver significant environmental, social and economic benefits.

Diseases arising from poor drinking water are a major cause of ill health. The level of provision of centralised or improved drinking water supplies in the region varies significantly, particularly for rural areas. This is even more the case for sewage collection systems which were unevenly developed in the Soviet period and now suffer from the effects of age. Azerbaijan suffers from this particular issue (see case study box on Azerbaijan). Sewage once collected requires treatment and in some cases the infrastructure is so old that it has ceased to function. In any case, the provision of such treatment has been limited in scope and in degree of treatment. However, it must be noted that some investment has improved treatment is a few limited cases.

All of these factors, if addressed, would improve health. Across the region, the benefits that would accrue from improved drinking water quality and sewage connection would be between 31 million and 66 million annual cases of diarrhoea avoided and between 832 and 1,674 deaths avoided. The annual monetised benefits would be between €4,772 million and €10,376 million for morbidity and between €836 million and €1,740 million for morbidity, giving total annual benefits of between €5,607 and €12,115. These are large benefits and would represent between 0.14% and 1.08% of the GDP of individual countries.

Surface water quality is variable across the region and, where it is poor, presents major disbenefits to health, society and economies. The potential benefits of improving surface water quality in Eastern ENPI countries and the Russian federation can be expected to be considerable. The WTP analysis suggests a range of monetized benefits from 0.11% to 1.73% of the GDP of individual countries. These are similar levels of benefits to that for drinking water supply and waste water treatment.

Water scarcity in the region is not universal, but is of critical importance in some countries – e.g. Azerbaijan and Armenia and some regions, e.g. parts of Georgia. However, droughts have been shown to cause significant economic disbenefits and, therefore, improving their management (e.g. through water efficiency measures) would have benefits.

It is, therefore, important for the countries of this region to ensure that the benefits of improved water management are integrated into future investment decisions. Infrastructure for water treatment or collection/distribution can be costly, but the benefits can be significant. It is, therefore, necessary for countries to improve their data gathering and assessment of the status and impacts of water quality, health, social and economic impacts to refine these analyses to improve decision making.

The countries should also set long term water quality targets. A lack of action implies a loss of significant benefits to society in these countries. However, to take this forward also requires a need to establish and improve current surface water quality monitoring capacity in order to accurately depict baseline status and assess distance to target.

The benefits arising from improved water management need to integrated into policy and practical decision making so that investment and management decisions can be made that will deliver wide positive environmental, social and economic outcomes.

5 WASTE

Key Messages - Waste
• Waste collection coverage is an issue in most ENPI East countries; none succeed in reaching full waste collection coverage, especially in rural areas. Better coverage would avoid wild tipping or unmanaged dumpsites, burying, open air burning… and its related impacts on health and environment. Jobs can be created as well as more viable living conditions. • A shift from dumpsites to well managed sanitary landfills would have a considerable environmental impact. Sanitary landfills avoid nuisance, odour, fires and smoke (often with dioxin emissions), runoff water impact, soil water impact, health risks from scavenging, etc. • Recycling reduces the amount of waste landfilled (and thus the related impacts), generates jobs and makes material resources available for the industry. Sorting at source and adapted collection systems are the first condition to reach high quality recycling. Waste is generally not separately collected, with the exception of some municipalities or under some pilot projects, which reduces the opportunities for recycling. The present informal recycling sector can be professionalised and its activities can grow considerably • Back yard composting and capital extensive (windrow) composting of source separated material are good solutions to divert biodegradable waste from landfills, and it creates a valuable material to fight soil degradation. • Biodegrading wastes cause the production of methane, a strong greenhouse gas, which escapes from landfills and dumpsites. Avoiding these emissions through enhancing collection coverage and diverting biodegradable waste from dumpsites and landfills is the first and major measure to take when addressing greenhouse mitigation measures in the field of waste policy • Complementary methane can be captured on well-equipped landfill sites. Captured landfill gas can be flared (oxidising methane to CO_2 and reducing its impact with a factor 25), or it can be used to generate electricity or to be distributed as natural gas. • Calculable and monetisable benefit assessments can be made on: surface of avoided dumpsites, amounts of supplementary collected municipal solid waste, amounts of supplementary composted or recycled waste, jobs created for collection and waste treatment, overall value of supplementary sound waste management, based on WTP, and marketable values of avoided CO_2 eq. emissions. This first ENPI wide assessment (using ENPI wide common targets) give the following order of magnitude estimates of the benefits:

Key Messages - Waste
• Enhanced waste coverage will likely lead to significant avoidance of polluted land – this first ENPI wide estimate suggests that this could be in the order of a 100 to 300 thousand m2 for from Armenia to Georgia and Azerbaijan to millions of m2 in other countries - 1 million m^2 in Belarus, 3.5million m2 in Ukraine and around 10 million in Russia.   • Increased waste treatment by expanding collection coverage and sanitary landfill capacity could avoid around 17.8 million tonnes of waste, lead to 15.6 million tonnes of additional waste recycled or composted and six and half thousand additional jobs generated in the region for landfill, recycling and composting   • Overall around 30 million more people could benefit from increased waste collection coverage under the target, leading to around €2.6 billion benefits per year for the region.   • There are considerable potential benefits from improved waste management also for climate mitigation. Over the region almost 4.9 billion m3 of methane could be avoided per year, with a value of around €4.6 billion per year.

5.1 Overview

Not only municipal solid waste (MSW) poses a significant problem, but also industrial waste and hazardous wastes (e.g. sludge from mining and enrichment industries, obsolete agrochemicals from Soviet times). The challenge is to reduce the growth in waste (i.e. prevention of waste) and then, following the waste hierarchy, to duly reuse/recycle waste and then finally to dispose of correctly – across sources of waste Industry in the region is currently less engaged in waste management: industries often stock the waste on their sites on adjacent land rather than recycling or disposing via due legal and sanitary means. Extended Producer Responsibility for products that have come to the end of their useful life has not yet been introduced in the region.

This report focuses on MSW collection and treatment. Waste prevention is clearly a key factor in the EU waste management strategy. However, for methodological reasons the benefits of waste prevention have not been assessed under this project

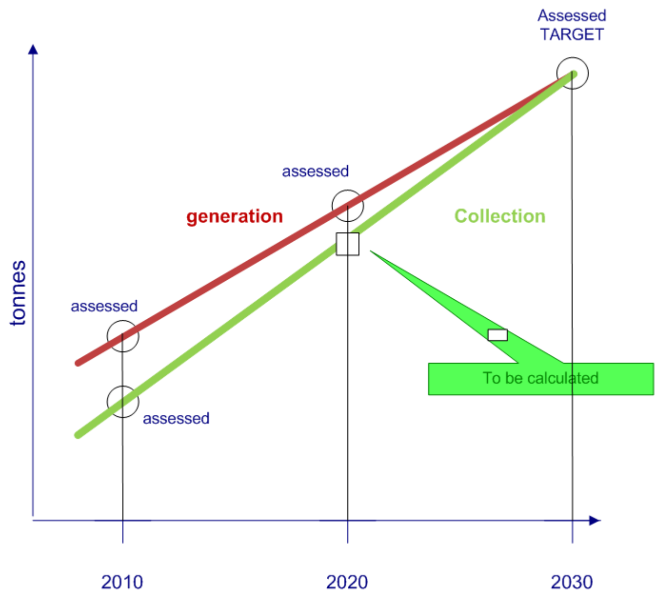
5.2 Current status of waste management in the region

Improved municipal solid waste management: In ENPI-east countries, the generation of domestic and industrial waste is increasing steadily due to urban expansion and economic development. Waste collection services are not covering the population of the whole country: some parts of the urban population are not served and the coverage of rural areas is even much lower. This leads to illegal dumping or wild burning, which has a negative impact on human health and the environment.

Nearly all collected MSW is sent to landfills. There are very few incineration facilities and recycling rates are very low. Considerable amounts of waste is dumped or burned in a non-controlled way. If no further treatment capacity is developed, this amount will increase further.

With targets for 2030 of 100% coverage of waste collection, 0% illegal dumping or burning, 50% recycling of glass, paper, plastics, metals, 70% recycling of construction and demolition waste, 65% of biodegradable waste diverted from landfills, considerable benefits can be reached. Although the ambitious targets are set at 2030, we calculated the benefits for 2020. We do not assume that these targets would be met in 2020, but we assume a linear evolution towards reaching the targets in 2030. In theory, for each year between now and 2030, the benefits can be calculated. We choose 2020 to be in line with the other environmental topics and parameters covered in this report.

Figure 5.1 Relation between basic year, target year & benefits year, example for collection coverage



Box 5.1 Definitions of key terms - waste

Dumpsite: non-managed site where waste is dumped without or with only a limited site management. To be distinguished from (sanitary) landfills. Dumpsites can be large scale fly-tipping sites for non-collected waste or they can be sites where waste is dumped after municipal waste collection.

Incineration: thermal destruction of waste in dedicated installations equipped with flue gas treatment, or co-incineration in energy plants or cement kilns working at comparable environmental conditions. To be distinguished from wild or uncontrolled occasional burning of waste.

Landfill, or sanitary landfill: disposal in managed sanitary landfill sites with a least an impermeable bottom liner, leachate capture, daily coverage, fencing and permanent staff.

Municipal solid waste (MSW): waste collected by services for the collection of household waste. It may contain waste from small enterprises or municipal services collected in the same collection scheme. Large quantities of construction and demolition waste and end-of-life vehicles are excluded even if generated by households. Industrial and agricultural waste is excluded as well.

Recycling: making a usable non-waste product out of waste. The recycling process does not stop at the level of pre-treatment (e.g., sorting) but ends when the waste is used as a raw material to make a non waste product.

Waste: everything one discards, intends to discard or is obliged to discard (definition in line with the EU Waste Framework Directive). Included is waste destined for recycling, even after a pre-treatment step. Excluded is clean soil, manure, nuclear waste. Economic value is no criterion to include or exclude something as a waste.

A better collection would lead to considerable surfaces of illegal landfill avoided, and considerable supplementary jobs created for waste collection. Better waste management will generate as well supplementary jobs. Finally landfill diversion and recycling or composting of biodegradable waste will led to supplementary benefits, such as availability of raw materials, soil improvement, avoidance of landfill emissions and nuisances etc.

5.3 Qualitative benefits of improved waste management

The benefits of a sound waste management system expand beyond keeping the day-to-day living environment clean and tidy. Waste management generates health, social, environmental and economic benefits, related to improved environmental (air, groundwater and surface water) quality, a more attractive environment and landscape, safeguarding the tourism potential, reduced CO_2 eq. emissions and climate change, energy production, availability of secondary raw materials from the recycling industry and prevention of primary resource depletion. A sound waste management system results in social benefits related to an improved environment to live in, better health and job creation.

The main benefits are included in table 5.1.

Table 5.1 Benefits associated with waste management improvements in ENPI East countries	

Health benefits	– Health benefits through avoided birth defects and various diseases:
	  – including cancers, asthma, respiratory diseases, that can be caused by exposure to hazardous emissions from substandard landfills, open burning and substandard incineration.
	  – resulting from ingestion of contaminated water or food.
	– Health benefits through avoidance of occupational injuries resulting from substandard waste collection, transport and treatment
	– Health risk prevention from dumpsite gleaning
	– Food safety protection against foraging herds of sheep or goats on dumpsites.

Environmental benefits	– Waste prevention leads to less natural resources used. It takes natural resources to produce waste, and waste is a loss of natural resources. Waste generation thus contributes to the overall depletion of valuable natural resources. – Environmental benefits resulting from avoided pollution: dumpsites are a significant source of pollution for soil (direct soil pollution, waste getting buried), air (biodegradation gasses, dust, bad odour, toxic emission from dumpsite burnings), groundwater(through leachate) and surface water (through runoff or through flooded dumpsites in or near river beds). – Substandard landfills and dumpsites emit primarily methane and CO_2, resulting from the decomposition of biodegradable waste, a major greenhouse gas (GHG) of concern for climate change. Sound waste management can contribute significantly to GHG reduction. – Recycling reduces the amount of waste that must be deposited in landfills. – Recycling is far more efficient, in terms of energy consumption, than producing something out of new raw materials. The greenhouse gas benefit of recycling is a reduction in emissions from the use of fossil-fuel energy in the extraction and manufacture of products from virgin materials versus secondary materials. There is a difference in energy/electricity use for the production of material from virgin inputs (i.e. from extraction of feedstock to manufacturing) versus recycled inputs (i.e. from collection to manufacturing). – Another greenhouse benefit of recycling, relates to the avoided methane emissions of degrading paper. Composting and diverting other biodegradable waste from landfills, results in less GHG emissions.
Economic benefits	– Benefits from availability of secondary raw materials. If waste is not being properly collected and recycled, waste generation is a loss of resources. – Recycling saves resources. For example, recycling newsprint, office paper and mixed paper saves trees; recycling of steel saves irons ore, coal and limestone. – In general recycling prevents environmental impact of mining or other raw material production ; recycling does not only conserves resources, but also reduces the need for natural resource extraction and reduces thus the impact of extraction, within the country or in other parts of the world. – Flee-tipped waste and litter causes direct impact on the local economy: through its effect on the quality on agricultural land, on touristic potential, by choking sewage and irrigation systems, by damaging infrastructure. – Recycling promotes energy efficiency, which reduces energy costs. recycling is far more efficient, in terms of energy consumption, than producing something out of raw materials. – Trading in emission reductions via the Kyoto mechanisms can make landfill gas

Table 5.1 Benefits associated with waste management improvements in ENPI East countries	
	capture economically viable, – Landfill gas capture and recovery generates a supplementary energy source, available for e.g. local communities adjoining a landfill site. – Development of waste management industry. Private-sector participation, through local private companies, could be appropriately used to improve the efficiency of waste management systems.
Social benefits	– Littering and illegal dumping reduce the quality and attractiveness of the landscape. – Waste management can generate jobs and income. Extended waste collection, shifts from dumpsites to managed landfills, incineration and the recycling industry generates a considerable number of jobs. – Communities living near dumps must bear with dust, litter, odour, insects and rats, which affects quality of life. – Noise related to the collection and transport of waste, can also be a public nuisance. – Sound waste management, in particular recycling, builds community and raises the environmental awareness, here citizens get together around the common cause of better waste management and a cleaner environment.

5.4 Waste collection coverage

5.4.1 Introduction

The major environmental challenge and pressure for the region consists of expanding the collection coverage both for urban and rural population. It can be observed that not all citizens benefit from centralised waste collection services. Especially in rural or less densely populated areas people are often deprived from a collection system set up by its municipalities, and have to take care of their municipal waste themselves. This leads to wild tipping, using non controlled dumpsites, self-burning or burying of all kinds of municipal waste. Although the degree of reuse can be very high and inventive in non-covered rural areas, the on-going shift in consumption patterns (e.g. the widespread use of plastics or of hazardous substances…) can cause problems even in an agricultural subsistence economy, problems that did not occur in a pre-industrialised world where waste could be easily managed by traditional means.

5.4.2 Benefits of improving waste collection – quantitative and monetary assessment

Expanding the collection coverage to 100 per cent in 2030 generates several benefits. The following benefits have been calculated under the project, for the year 2020:

- Avoidance of land being polluted by wild tipping or non-managed waste dumpsites, assuming that all waste collected is disposed at least in sound landfill sites that meet essential environmental requirements.

- Job generation by supplementary waste collection, these jobs are directly generated by increased collection efforts. Fees are to be paid by the public service providers of waste collection and will be paid to often semi- and unskilled workers. This generates a considerable social benefit. Supplementary jobs linked to increased recycling and improved disposal are included in chapter 3.4. The table below quantifies the environmental benefits of avoided dumpsites and the social benefits of job creation for waste collection.

Table 5.2 Quantified environmental and social benefits in 2020 of enhanced waste collection coverage

	Quantitative		Monetary
	m^2 of polluted land avoided	Nr of jobs generated	Fees generated million € PPP
Armenia	134,492 m^2	99	0.8
Azerbaijan	329,762 m^2	243	2.7
Belarus	1,088,106 m^2	801	10.8
Georgia	262,478 m^2	193	1.2
Moldova	692,148 m^2	509	2.8
Russia	10,329,957 m^2	7,602	314
Ukraine	3,510,371 m^2	2,583	25.6
Total	16,347,314 m^2	12,030	358

Expanding the collection coverage is the first step towards better waste management, but it is not sufficient. Non-collected waste is always disposed of in substandard ways, either by dumping, burying, incineration in a non-controlled way. However, a large fraction of waste that is collected still is dumped, by the local authorities, on a non-managed dumpsite. Expansion of the waste collection coverage should therefore go hand-in-hand with the expansion of sound waste management capacity.

5.5 Waste treatment

5.5.1 Introduction

The main waste treatment option for collected municipal solid waste consists of dumping in a non-controlled dumpsite, or landfilling in a sanitary landfill. The transition from dumpsites to landfills equipped with an impermeable bottom liner, leachate capture, daily coverage, fencing and permanent staff, is far from completed in most ENPI-east countries. Recycling, composting and incineration of MSW are currently underdeveloped.

The primary target is to avoid non-controlled waste dumping, and to replace it by disposal in sanitary landfills. Supplementary targets have been defined under the project, based on European Union targets for recycling of specific waste fractions, and for landfill diversion of biodegradable waste. The recycling targets are applicable on the amount of waste being generated in 2030, and the landfill diversion target, to be reached in 2030, is based on a percentage of biodegradable waste being generated in 2010. The target year is set at 2030, because of the ambitious character of the targets. It has been calculated though to what degree these targets will be approached in 2020.

5.5.2 Benefits of improving waste treatment – quantitative and monetary assessment

The environmental benefit consists of avoided dumping and increased recycling or composting of waste. This leads to societal benefits in the fields of environmental and health impact reduction, resource savings and quantifiable job creation.

Table 5.3 Quantified environmental and social benefits in 2020 of enhanced waste treatment, in compliance with set recycling and landfill diversion targets

	MSW generation in 2020 (tonnes)	Avoided waste dumping, both by expanding collection coverage and sanitary landfill capacity (tonnes)	Supplementary recycled or composted waste (tonnes)	Supplementary jobs generated, for landfill, recycling, composting
Armenia	1,324,849	652,943	202,412	157
Azerbaijan	3,788,140	648,778	385,676	159
Belarus	7,382,635	1,109,868	795,828	269
Georgia	961,209	301,543	115,262	73
Moldova	2,865,165	970,125	540,288	234
Russia	77,100,496	10,536,556	9,646,756	3,765
Ukraine	23,817,341	3,580,578	3,932,589	2,038
Total	117,239,835	17,800,391	15,618,811	6,695

The major environmental challenge consists of developing (low capital intensive) alternatives for dumpsites; developing sanitary landfill capacity and recycling and composting capacity (see below). Shifts from dumping to landfilling, incineration, recycling and composting leads to following job creation in the table below:

Table 5.4 Detail on job creation for the different waste treatment options in accordance with the set targets.

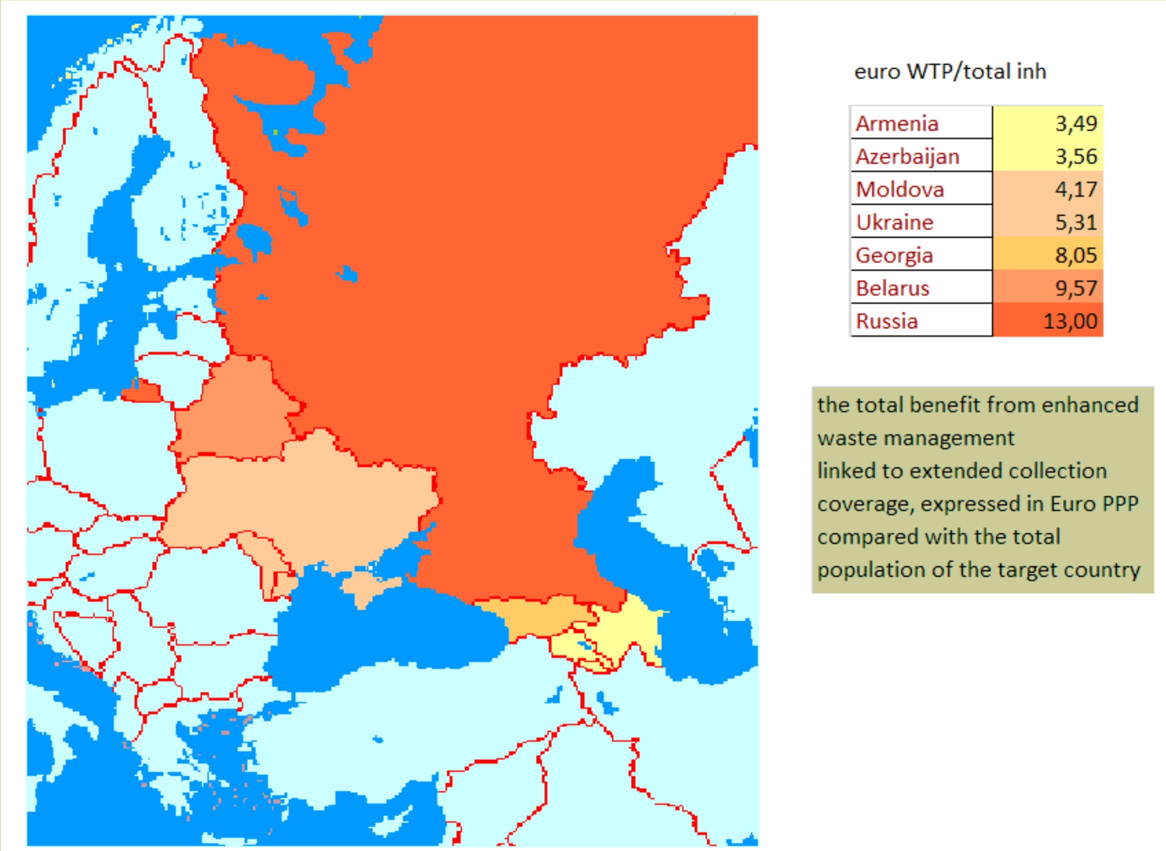
	Landfill	Incineration	Recycling	Composting
	Number of supplementary jobs generated in 2020			
Armenia	108		34	15
Azerbaijan	63		24	71
Belarus	75		125	68
Georgia	45		20	8
Moldova	149		63	22
Russia	100	1321	1619	726
Ukraine	709	663	373	292
Total	1249	1984	2258	1202

People are prepared to pay for sound waste collection and treatment, when they trust in the disposal and recycling quality and when they experience the environmental and social benefits of better waste management. The willingness-to-pay is assumed to be 1% of the total household income. When taking into account the number of inhabitants supplementary served with sound waste collection and treatment, following benefits for society can be derived in the table below:

Table 5.5 Monetised overall societal benefits for better waste collection and management, based on willingness-to-pay of supplementary served population.

	Quantitative	Monetary
	Number of people supplementary served	Societal benefits generated Million € PPP
Armenia	311,125	13. 5
Azerbaijan	814,977	43.4
Belarus	1,379,096	114.6
Georgia	1,138,140	20,4
Moldova	804,765	18.0
Russia	19,576,812	2,074
Ukraine	6,438,353	318
Total	30,463,268.00	2,602

Box 5.2 The size of achievable benefits for enhanced waste management, compared between the ENP(I)-East countries



The value of extending waste collection and treatment over a number of inhabitants in 2020, in line with the target of reaching 100% coverage in 2030, can be expressed in a total value in Euro PPP. To make these figures relative, and to enable benchmarking between countries, we divided this number by the total size of the country expressed in total numbers of inhabitants. Most value can be realised, in relative terms, in Ukraine, Russia, and Moldova, least in Armenia, Azerbaijan, Belarus and Georgia. But in absolute values the benefits are in any case quite considerable.

Box 5.3 Case study: development of recycling of municipal solid waste in Yerevan

The methodology, developed to assess the environmental, social and economic benefits of a country on the issue of waste, can be applied on each regional entity for which sufficient data is available. In this case we demonstrate the benefits of a better waste management for the city of Yerevan in Armenia.

Currently almost all waste (non-hazardous, hazardous and medical waste) is going to dumpsites. None of them is in accordance with the sanitary and hygienic standards. Waste is collected and transported to landfills without sorting. Neither waste recycling, nor reuse takes place. There are no facilities for hazardous waste. Garbage is dumped into a dumpsite and then flattened and covered by gravel.

The biggest site in Armenia, serving Yerevan, is Nubarashen dump, with a daily intake of about 450-500 tons of waste. The Japanese company 'Shimizu' implemented a project on the capture of methane. Other, smaller dumps equally serve the city. Major issues of all dumpsites are the presence of hazardous substances, smoke from self-burning, methane emissions, a strong smell, runoff- and groundwater contamination, wind-blown waste, health risks through scavenging, loss of material resources.

We assess actual (2010) and future (2020) waste generation in Yerevan at 279 and 1,226 thousand tonnes. The steep increase is caused both by demographic and economic growth figures, increasing both the average and total generation.

In this case we set waste management targets at:

- 100% collection coverage of the total population of Yerevan
- 0% of collected waste dumped in uncontrolled dumpsites
- 50% recycling of all generated glass, paper, plastic and metals in municipal waste
- 70% recycling of construction and demolition waste
- 65% of biodegradable waste generated in 2010 diverted from landfills.

The targets have to be reached in 2030. Benefits generated from this shift in waste policy will augment every year from now to 2030. In 2020 these yearly benefits can be assessed as follows:

- 127 thousand tonnes of municipal waste supplementary collected
- 604 thousand tonnes of municipal waste are not being dumped in uncontrolled dumpsites 193 thousand tonnes are supplementary composted or recycled.
- 12.45 ha of polluted land avoided.
- 92 supplementary jobs generated for waste collection
- 145 supplementary jobs generated for waste treatment
- 25.63 million € PPP benefits generated for society, based on willingness to pay
- between 3.6 and 5.2 million € PPP benefits generated from avoided greenhouse gas emissions.

5.6 Methane emissions from waste

5.6.1 Introduction

When biodegradable waste is landfilled or dumped, anaerobic conditions may be generated in which it starts to decompose by bacterial activity, generating among other methane and

CO_2 emissions. These greenhouse gasses contribute to the global warming. Socio-economic benefits are to be found in reduced global warming, reduced environmental and nuisance impact and use of the landfill gas as an energy resource.

5.6.2 Benefits of improving methane capture – quantitative and monetary assessment

We compare a baseline scenario, in which no changes occur in the way waste is collected and treated, with a target scenario, in which by 2030 the above mentioned recycling and landfill diversion targets would be met. See paragraph 5.5. The landfill gas emissions in the baseline scenario and in the target compliant scenario in 2020 are derived from an assessment of the total amount of waste landfilled, dumped and not collected. In the target scenario we supplementary assume that 20% of all methane generated on landfills can be captured by landfill gas collection systems. The difference between both shows the amount of landfill gas emissions that supplementary can be avoided. The socio-economic benefits can be expressed in the marked values of avoided CO_2eq. In the table below the upper value of 56 €/T in 2020 is used.

Table 5.6 Environmental and monetised benefits from avoided methane emissions through better waste management

	Quantitative	**Monetary**
	Methane emissions avoided in million m³	Value for avoided CO_2 eq. emissions in million €
Armenia	50	47
Azerbaijan	149	142
Belarus	304	289
Georgia	26	25
Moldova	80	77
Russia	3,498	3,330
Ukraine	748	712
Total	4855	4622

The major challenge consists of landfill diversion and recycling or composting of biodegradable waste, together with the transit to sanitary landfills and the equipment of the latter with methane capture installations. Next to the value of avoided CO_2 an interesting energy source can be found in the captured methane, either as a replacement for natural gas, or as a source to generate energy.

5.7 Conclusions – waste related benefits

Waste management is an area in which the authorities in most of the ENPI East countries have great potential to improve the quality of public health, conserve natural resources through increased recycling rates and mitigate climate change. Most waste could be converted into a resource to reduce the final volumes of waste and subsequently the cost of final disposal, and to save natural resources. This requires a change of existing waste practices and the implementation of strategies aiming at waste prevention, separate collection, recycling, composting and waste treatment before final disposal. Improved waste management will generate jobs and income, with recycling generating considerably more jobs than landfilling or incinerating waste. All stakeholders (national, regional and local governments, the private waste management sector and waste generators, both households and industry) in the countries should contribute to establishing a sound waste management system.

6 NATURE

Key messages - Nature

Biodiversity is of immense intrinsic value and human well being depends upon it. It is the 'natural capital' that provides a country, its economy and its people with a flow of goods and services that are fundamentally important for prosperity, livelihoods and well-being. The values we receive from our natural capital are immense, and failure to adequately take these values into account in our decisions exposes us to the risk of losing yet more of it

Biodiversity in the region

- The status of biodiversity is poorly known in much of the region, but it is clear that there is on-going degradation of most ecosystems, and many associated species are declining. Consequently a substantial number of species are threatened nationally, some of which are at risk of global extinction.
- The main threats to biodiversity in the region include: logging natural / near-natural forest, and expansion of commercial forestry (especially in Russia), overgrazing and desertification, expansion of agricultural land and agricultural intensification, wetland drainage, pollution, illegal hunting and overexploitation of some species, especially fish, and the spread of invasive species.
- One of the principal means of protecting biodiversity (and associated natural capital) is through the protection of areas of very high biodiversity that are at risk of degradation. This is recognised by the CBD, which has set a target of achieving at least 17% protected area coverage of terrestrial and inland water bodies, and 10% of marine areas, by 2020. Although it is difficult to obtain consistent and up-to-date data on protected area coverage (due to differing national interpretations of protected area definitions, and on-going protected area expansion, it is clear that the achievement of the CBD target would substantially increase the protection of biodiversity within the region. Only Georgia has a protected area protection target that exceeds the CBD target (20.2 by 2010). Most other countries would need to increase their current coverage considerably to reach it, and go beyond their intended targets. The greatest increase in protected area coverage would be for Russia as its current protected area coverage is only 2.4%. However, it is clear that increases in protected area coverage would particularly benefit the biodiversity rich Caucasus region, the peatlands of Belarus and the wetlands and steppe lands of Ukraine.
- It must be remembered that protected area coverage is a crude measure of biodiversity conservation effectiveness, as the strength of protection and appropriateness of land management measures within protected areas is of key importance. In this respect it is clear that considerable improvements could be made in the effectiveness of protected area management in the region.
- There is considerable uncertainty over the potential ecosystem service related benefits of increasing protected are coverage in the region. However, the assessments indicate that the most important benefits of increasing protected area coverage in the region are likely to be related to the protection of carbon reserves

Key messages - Nature

(especially in the peatlands of Belarus), the improvement of raw water resources in terms of quality and quantity (through better protection and management of vegetation in vulnerable catchments), capturing of pollutants from waste water and run-off (e.g. from agricultural land) in catchments of water bodies that are polluted or vulnerable to further pollution and habitat provision for threatened species. Some significant benefits could arise with regard to cultural services, but it is uncertain to what extent protected areas are needed to maintain such services in the region.

Forests, deforestation and carbon storage

- **Forest cover** in the ENPI East region as a whole is at almost 48 % of territory; the highest level is in Russia both in terms of percentage coverage (nearly 50%) and particularly in area coverage (809 million hectares). Coverage in Belarus and Georgia is also very high with both around 40% coverage.
- **Deforestation** is an important issue across countries, as a loss old forest is generally not offset and compensated by a gain in the same area of new forest elsewhere. Old natural or semi natural forests generally have much higher carbon storage and important wide range of ecosystem services than new forest growth/plantations.
- **Forests mostly have multiple uses**, but a range have been designated specifically for production (particularly in Russia, Belarus and Ukraine), for the protection of soil and water (particularly in Azerbaijan and Georgia, and also Armenia). A range of forests are also designated for the conservation of biodiversity (linked to protected area designation).
- **Carbon storage:** ENPI East forests contain just over 34 billion metric tons of carbon in living forest biomass, equivalent to almost 125 billion tCO_2. This is, however, an underestimate of the carbon storage in forests given that there are also important quantities in the soil and litter.
- Meeting the ENPI wide target of halting deforestation by 2020 will (at a net level) only be a relevant target for Armenia and Georgia – with the potential to avoid the emissions of about 4.4 million tonnes of CO_2 from lost living forest biomass. This is small compared to the total carbon store, but nevertheless significant.
- **Value of carbon storage, avoided loss and stock gains:** Assuming a value of CO_2 of 17.2 €/ton (low) and 32 €/ton (high) in 2010, the value of the carbon currently stored by the ENPI East forests ranges between 2 to 4 thousand billion € (see later point on stock and marginal values). This is an indication of the value of the carbon stored in the living biomass today.
- By 2020, the **stock of carbon in living biomass** - assuming projected carbon values of 39€/ton (low) and 56€/ton (high) – would suggest values of between nearly 5 and 7 thousand billion €. In Georgia and Armenia, under the halting forest loss by 2020 target, between 170 and 250 million € of potential carbon losses could be avoided.
- In other ENPI countries, the 'halting deforestation target' does not apply when looking at the national totals, hence to underline the benefits of forests as carbon store an estimate has been made of the projection in carbon value from the **continued growth of forests** – this has been estimated to lead to a carbon gain of 6

Key messages - Nature
to 8.6 thousand million € for the ENPI East region. **Land degradation** • **Agricultural production** across the ENPI East accounts for between 6% and 18% of GDP, with an overage of 10%. It is, therefore **an important contributor to the economy**. • However, much agricultural land suffers from degradation (loss of soil or soil quality, salination, pollution damage). Depending on the country, anything from **6% to 100% of the agricultural land is severely or very severely degraded**. • **Better crop management systems** would tackle much land degradation, reducing the loss of soils, reducing soil salinity and replenishing nutrients and maintaining soil structure. • If these poor management problems are address, across the region **crop yields would increase from between 2.9% to 16.8%.** The benefits of improved crop production include health, environmental and on- and off-farm social and economic benefits. The **estimated total benefit is € (PPP) 8.1 – 14.6 billion in 2020**. This represents 0.1-0.15% of GDP in Georgia and Russia and 1.5-2.0% of GDP in Ukraine and Moldova

6.1 Overview

All countries have an interest in understanding the importance of their country's natural assets – its land and forests, its coast and marine areas, its inland waters and wetlands, its biodiversity. Strictly speaking, biodiversity as defined by the CBD[23] is the variability amongst living things, but the term is commonly more widely interpreted such that it incorporates their abundance as well. This accords with the increasing recognition that biodiversity has a wider importance beyond traditional nature conservation concerns; it is the basis of 'natural capital'. This natural capital provides a country, its economy and its people with a flow of goods and services that are fundamentally important for prosperity, livelihoods and well-being. The values we receive from our natural capital are immense, and failure to adequately take these values into account in our decisions exposes us to the risk of losing yet more of it (TEEB 2011).

This chapter looks at the importance of nature in the ENPI countries. It starts (section 6.1) by articulating the ecosystem service issue so as to create a basis and context for the specific areas of analysis of this chapter, namely:

- Biodiversity itself – important for its intrinsic values and for the benefits that we derive from it. The extent of the biodiversity is presented in section 6.2.

23 is *'the variability among living organisms from all sources, including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystem'.* (Article 2, Convention on Biological Diversity (CBD) (UN 1993).

- Forest cover and deforestation impacts on carbon stores – forest are critical carbon stores for the planet (and much more). Appreciating the capital stock and the need to halt or avoid deforestation (and degradation) is critical. Section 6.3 presents the parameter of 'halting deforestation'.
- Section 6.4 looks at cropland degradation – this is important for productivity and wellbeing as well as for a range of ecosystem services.

Whilst this study and a single chapter cannot do justice to the fundamental and wide values of nature, the aim here is to highlight some specific aspects that can provide robust evidence of some of the biodiversity and economic benefits that may be gained from improved nature conservation. It is hoped that this will show that it would be in the interests of nations to explore further the value of nature and of course move to implementing the 20 targets under the CBD Strategic Plan 2011-2020.

Insights on nature, natural capital and ecosystem services[24]

Ecosystem Services refer to the flow of benefits that people obtain from ecosystems (MA 2005a). These include:

- *provisioning services* (e.g. food, fibre, fuel, water);
- *regulating services* (benefits from ecosystem processes that regulate e.g. climate, floods, disease, waste and water quality);
- *cultural services* (e.g. recreation, tourism and aesthetic, spiritual and ethical values);
- *supporting services* necessary for the production of all other ecosystem services (e.g. soil formation, photosynthesis, nutrient cycling).

As noted in TEEB 2011, Ecosystem services flow from the 'natural capital stocks', like interest or dividends from the stock (also sometimes termed 'natural assets'). 'Natural capital' is an 'economic metaphor for the limited stocks of physical and biological resources found on earth' (MA 2005a). See section 1.3 and Chapter 3 for additional definitions and insights on 'natural capital' and TEEB Ecological and Economic Foundations (2010).

The relationship between biodiversity and ecosystems (see box below) and their ability to deliver vital services is complex and variable. Ecosystems are components of biodiversity and species are essential components within those ecosystems. The loss of components of biodiversity may trigger a significant and detrimental change in services provided by the ecosystem concerned. Depending on the circumstances, such changes can (initially) be subtle or make ecosystems less stable and more vulnerable to collapse. The loss can be linear in some case, exponential in others (fragile ecosystems near tipping points) or initially very low (if the loss of one component of the ecosystem is substitutable by another) though

24 This section builds on TEEB (2011)

with a risk of sharp loss later[25]. If an entire ecosystem is lost, this will have a significant structural impact with direct human, social and economic costs.

Box 6.1 The relationship between biodiversity and ecosystems

Biological diversity means *'the variability among living organisms from all sources, including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems'* (Article 2, Convention on Biological Diversity (CBD) (UN 1993). The term covers every form of life on earth (plants, animals, fungi and micro-organisms), the diversity of communities that they form and the habitats in which they live. It encompasses three levels: ecosystem diversity (i.e. variety of ecosystems); species diversity (i.e. variety of different species); and genetic diversity (i.e. variety of genes within species).

Ecosystem means '*a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit*' (Article 2, CBD) (UN 1993). Every ecosystem is characterized by complex relationships between living (biotic) and non-living (abiotic) components (resources), sunlight, air, water, minerals and nutrients: the quantity (e.g. biomass, productivity), quality and diversity of species (e.g. richness, rarity) all play an important role. The functioning of an ecosystem often hinges on certain species or groups of species that perform key functions e.g. pollination, grazing, predation, nitrogen fixing.

25 It depends on the ecosystems functional diversity and related redundancy levels. Thus some components can be lost with no perceptible impacts on ecosystem services. The main issue is that we often do not know what can be lost without detrimental impacts and we do not know how close we are to key thresholds.

Box 6.2 Ecosystem services – overview and definitions

Provisioning Services are ecosystem services that describe the material outputs from ecosystems. They include food, water and other resources.

Food: Ecosystems provide the conditions for growing food – in wild habitats and in managed agro-ecosystems.

Raw materials: Ecosystems provide a great diversity of materials for construction and fuel.

Fresh water: Ecosystems provide surface and groundwater.

Medicinal resources: Many plants are used as traditional medicines and as input for the pharmaceutical industry.

Regulating Services are the services that ecosystems provide by acting as regulators eg regulating the quality of air and soil or by providing flood and disease control.

Local climate and air quality regulation: Trees provide shade and remove pollutants from the atmosphere. Forests influence rainfall.

Carbon sequestration and storage: As trees and plants grow, they remove carbon dioxide from the atmosphere and effectively lock it away in their tissues.

Moderation of extreme events: Ecosystems and living organisms create buffers against natural hazards such as floods, storms, and landslides.

Waste-water treatment: Micro-organisms in soil and in wetlands decompose human and animal waste, as well as many pollutants.

Erosion prevention and maintenance of soil fertility: Soil erosion is a key factor in the process of land degradation and desertification.

Pollination: Some 87 out of the 115 leading global food crops depend upon animal pollination including important cash crops such as cocoa and coffee.

Biological control: Ecosystems are important for regulating pests and vector borne diseases.

Habitat or Supporting Services underpin almost all other services. Ecosystems provide living spaces for plants or animals; they also maintain a diversity of different breeds of plants and animals.

Habitats for species: Habitats provide everything that an individual plant or animal needs to survive. Migratory species need habitats along their migrating routes.

Maintenance of genetic diversity: Genetic diversity distinguishes different breeds or races, providing the basis for locally well-adapted cultivars and a gene pool for further developing commercial crops and livestock.

Cultural Services include the non-material benefits people obtain from contact with ecosystems. They include aesthetic, spiritual and psychological benefits.

Recreation and mental and physical health: The role of natural landscapes and urban green space for maintaining mental and physical health is increasingly being recognized.

Tourism: Nature tourism provides considerable economic benefits and is a vital source of income for many countries.

Aesthetic appreciation and inspiration for culture, art and design: Language, knowledge and appreciation of the natural environment have been intimately related throughout human history.

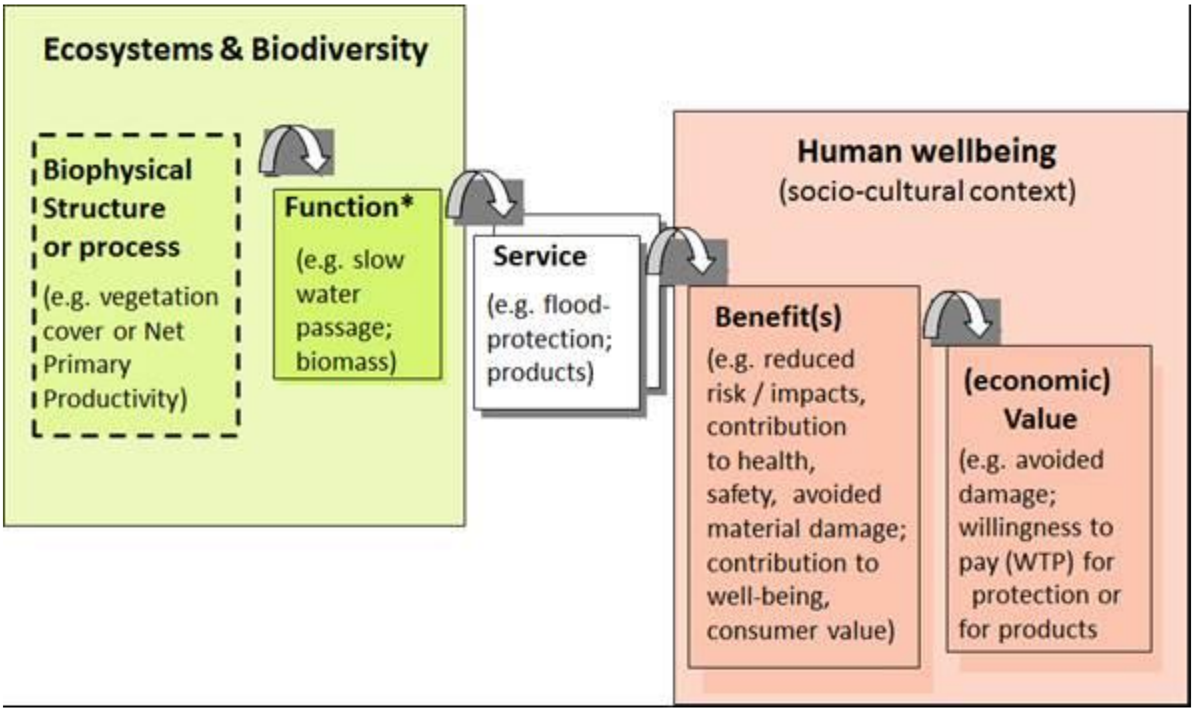
Spiritual experience and sense of place: Nature is a common element of all major religions; natural landscapes also form local identity and sense of belonging.

Icons designed by Jan Sasse for TEEB. They are available for download at www.teebweb.org

From TEEB (2011)

Many factors influence ecosystem functions, resilience and the likely extent of ecosystem services and also the changes to ecosystem services. Examples include species diversity and viability, level of biomass, quality and structure of natural habitats and level of genetic diversity. Some services are directly linked to species' detailed composition and diversity (e.g. pollination, many cultural services). Others, like flood regulation, depend on the role of physical structures and processes at the ecosystem scale (for more detailed scientific discussion, see TEEB Foundations 2010) (see Figure below).

Figure 6.1 The pathway from ecosystem structure and processes to human well-being



Source: Adapted from Haines-Young and Potschin (2009) and Maltby (2009)

Many economic sectors depend on biodiversity and ecosystem services to a varying extent, including agriculture, fisheries, forestry, development, health, energy, transport and industry. Several need 'natural capital' for their flow of inputs, research, new products and business innovation (TEEB 2011).

As noted above, this chapter focuses on a subset of issues – first biodiversity, looking at the level of biodiversity protection; then looking at deforestation and forest carbon issues, and finally looking at rangeland degradation. Other issues to do with natural capital – for example the provisioning of clean water are explored in the water chapter. The issue of natural capital and the value of nature is a fast moving field since the Millennium Ecosystem Assessment came out in 2005 (MA, 2005) and accelerated by the TEEB process (TEEB 2008, 2009, 2010 and 2011) and recognised in the CBD Strategic Plan agreed and launched at the COP 10 in Nagoya (CBD 2010).

6.2 Biodiversity protection

6.2.1 Introduction

One of the most effective means of conserving biodiversity is through the establishment and appropriate management of protected areas. An area is considered by IUCN to be protected for nature conservation purposes if it is 'a clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values' (Dudley, 2008). These can be managed by governments, privately, have shared governance and also potentially involve community management. The benefit assessment of this sub-theme therefore uses the proportion of land designated as protected areas in each country as an indicator of the country's efforts to maintain biodiversity.

The proportion of land designated as protected areas (in accordance with IUCN definitions) is a widely used indicator of efforts to conserve biodiversity, and is for example included in the CBD set of biodiversity indicators[26] and the SEBI (Streamlining European Biodiversity indicators) set used in the EU[27]. This is because protected areas are a key instrument used to conserve biodiversity and reasonably comprehensive and standardised data exist for most countries on national protected area designations, which have been compiled in a central World Database of Protected Areas (WDPA)[28]. However, as further discussed below, it should be remembered that the formal protection of a site does not necessarily mean that the level of protection and management of the site is sufficient to adequately conserve biodiversity within it. There are also other means of conserving biodiversity that do not need protected area designation, and conservation measures in the wider environment (i.e. outside biodiversity-rich areas) is also important.

6.2.2 Current status in the region

Overview of key ecosystems

The ENPI Eastern area includes a very wide range of biomes and habitats, as it covers such a large area and latitudinal range. Russia is a vast area that alone includes polar deserts, tundra, boreal and temperate forests, steppe grasslands, arid shrublands and deserts. Importantly large areas of Russia are relatively unaffected by human activities and therefore substantial areas of natural or near habitat remain, especially in the boreal and polar regions.

The Caucasus region (which within the study region includes part of Russia and the whole of Armenia, Azerbaijan and Georgia) is considered to be globally outstanding for biodiversity

26 CBD biodiversity indicators

27 http://biodiversity-chm.eea.europa.eu/information/fol168004

28 http://www.wdpa.org/

and is among the planet's 25 most diverse and endangered hotspots[29]. The Caucasus eco-region is also identified as having global significance by WWF due to the diverse number of endemic species, and the specific evolutionary processes and unique historical floral and faunal development. The area is of importance as a result of its diversity of habitats, climates and altitudes and evolutionary history.

The ENPI Eastern region also has a range of marine habitats, including those of the arctic sea, western Pacific, Mediterranean and the inland Caspian and Black Seas.

Status of biodiversity and threats

As parts of the region are remote and relatively little developed threats to biodiversity are in some areas relatively low. However, threats are increasing as a result of economic developments, especially in the more highly populated areas. According the country reports the most widespread and significant threats include:

- Expansion of commercial forestry, with logging of some areas of pristine natural forest (especially in Russia).
- Wetland drainage.
- Overgrazing grasslands and other habitats by livestock, leading to vegetation degradation, soil erosion and desertification.
- Agricultural expansion (e.g. through conversion of grasslands to arable farming) and intensification (e.g. irrigation, intensive use of pesticides and fertilizers).
- Contamination of the environment (land and water resources) with industrial and urban wastes.
- Infrastructure development resulting in habitat loss, fragmentation and disturbance.
- Illegal hunting and overexploitation of some species, especially fish.
- Invasive species, particularly fish and some exotic plants.

Protection area coverage

The extent of terrestrial protected areas in each country in the region is presented below, according to IUCN category (see Table 6.1), together with an estimate of the percentage land area currently covered, and national targets for coverage (if they exist or are known). The assessment has revealed that it is difficult to obtain consistent and up-to-date data on protected area coverage, this is primarily due to differing national interpretations of protected area definitions, which has been further complicated by changes to the IUCN definitions of protected areas and their categories in 2008. Furthermore, many countries are currently expanding their protected area networks and reviewing their structure and governance. As a result central databases such as the WDPA do not always have up-to-date data. Data on marine protected areas is especially incomplete and inconsistent, and therefore it has not been possible to compile an overall assessment of progress towards the CBD target for marine protected areas.

29 identified by Conservation International as areas distinguished by their special biodiversity which at the same time are seriously under threat

Despite these data limitations, it is clear that the achievement of the CBD target for terrestrial protected areas would substantially increase the protection of biodiversity within the region. At the moment the highest levels of protection appear to be within the countries of the Caucasus, which reflects their exceptional biodiversity importance. But the maximum protected area coverage in the ENPI East region is only 12.7% and five countries have protection percentages below 10%. Russia only has 2.74% protected area coverage, which is of particular concern given the importance of many of its habitats and populations of highly threatened species. However, the low protection level may also partly reflect the relatively low pressures on biodiversity in some of the country's large sparsely populated regions.

Table 6.1 Protected Area coverage

Country	Area (km2) by IUCN Protected area type								
	I	II	III	IV	V	**Total PA area (km2)**	PA % of land (including water bodies)	National PA target %	Refs/ Notes
Armenia	361	2453		975		**3789**	12.7%	10%	1
Azerbaijan	1842	n.d.	n.d.	3193	n.d.	**8762**	10.1%	None	2
Belarus	No data (n.d)					n.d.	7.7%	9-10%	3
Georgia	1415	2707	3	640	345	**5111**	7.3%	20.2% (2010)	4
Moldova	193		281			**474**	1.4%	5.5% (2015)	
Russia	337000	70000	41000	n.d.	n.d.	n.d.	2.7%	?	5
Ukraine	3767	7355	239	49		**28793**	4.8%	?	6

Refs / notes:

Data sources are assessments by country report authors, unless otherwise indicated. 1, Category III areas are under revision. Area includes Lake Sevan (1252 km2). 2, Category I and IV areas are based on WDPA (world database on protected areas) downloaded GIS polygon files on 19 August 2011 http://www.wdpa.org/ErrorPage.aspx?aspxerrorpath=/QuickSearch.aspx . According to the CBD, Azerbaijan had no official national target for Protected Areas as of 2006 (Azerbaijan NBSAP 2006. http://www.cbd.int/doc/world/az/az-nbsap-01-en.doc). 3, National target based on The Fifth National Communication UNFCCC, Belarus, 2010. The date that the target relates to is uncertain. 4, Target based on UNDP (2009). 5. http://www.forest.ru/rus/publications/dnevnik/2.html http://old.de.msu.ru/~vart/doc/gef/GEF_B/IR_OOPT/IR1_01.html 6

Box 6.3 Protected area management categories defined by IUCN (Dudley, 2008)

CATEGORY Ia: Strict Nature Reserve: protected area managed mainly for science

CATEGORY Ib Wilderness Area: protected area managed mainly for wilderness protection

CATEGORY II National Park: protected area managed mainly for ecosystem protection and recreation

CATEGORY III Natural Monument: protected area managed mainly for conservation of specific natural features

CATEGORY IV Habitat/Species Management Area: protected area managed mainly for conservation through management intervention

CATEGORY V Protected Landscape/Seascape: protected area managed mainly for landscape/seascape conservation and recreation

CATEGORY VI Managed Resource Protected Area: protected area managed mainly for the sustainable use of natural ecosystems

Box 6.4 Cases- biodiversity: Ukraine and Georgia

In terms of biodiversity, **Ukraine** is rich in flora and fauna, with more than 25,000 species of plants and fungi and 45,000 species of animals. Ukraine's uniqueness is the presence of an extensive steppe ecosystem which is one of a kind for Europe.

The observed increase in the number of rare and endangered species indicates high intensity of biodiversity loss in Ukraine. Ukrainian ecosystems are threatened mostly by agricultural activities (land conversion for agriculture, high input farming methods). Other threats related to productive uses of natural resources include forestry, non-sustainable tourism and recreation, and impacts on water (loss of wetlands, pollution, overfishing, changes to the hydrological regime). Socio-economic issues directly impact biodiversity in Ukraine. The relatively large share of the population that falls below the poverty line (approximately 20%) can adversely affect biodiversity, as evidenced e.g. by fish poaching in the rivers and the Black Sea, and by illegal logging of firewood in the Carpathians. These threats are exacerbated by the lack of good governance and enforcement and by the lack and of public awareness.

In the Steppe region, where the most intensive agriculture is practiced, the overall downward trend has been the most dramatic. The conversion of much of the steppe ecosystem's grasslands to agricultural lands without maintaining natural habitat, unsustainable forestry practices and infrastructure development has had a devastating effect on the populations of many plant and animal species.

The protected areas system is apparently inadequate to protect biodiversity, considering the speed of its loss. Although the area under protection has increased by 75% since 1993, the current level of 5.4% continues to be inadequate to maintain or improve upon the biodiversity base. The low percentage of protected lands is compounded by an uneven distribution across the country as well as across landscape types. Most reserves are concentrated in the west and south. This leaves many important biomes with inadequate protected reserves. Due to poor management (e.g. most protected areas have no management plan), lack of resources and weak enforcement, existing areas could be referred to as 'paper parks'.

Georgia holds the major part of the region's biodiversity with almost all Caucasus ecosystems and habitats represented and a high number of globally threatened and endemic species. However, the biodiversity of the Caucasus region is being lost at a rapid rate due to poverty (e.g. overfishing, poaching), unsustainable nature resource management and improper forestry (e.g. illegal logging) and agriculture practices (e.g. overgrazing, inappropriate irrigation) as well as future risks from climatic factors. These practices are resulting in habitat degradation and fragmentation, significant pollution of many surface waters and land degradation (erosion). Generally, there is a lack of understanding and awareness at all levels of society of the value of its biodiversity and of the need to conserve it.

6.2.3 Potential environmental improvements

In order to assess the benefits related to protected areas an ENP study-wide protected area coverage target was used, based on the CBD Strategic Plan for 2011-2020 (see Box 6.5), are at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas (if applicable), are conserved through effective management practices. This was used as the target for the ENPI study.

It should be noted, however, that the CBD target may not be adequate according to national circumstances (including the importance of biodiversity in the country and the need for protected areas to reduce threats to it). National targets are therefore also considered, as they may be account the biodiversity importance of the country and the need for protected area designations. The CBD target is therefore more of a tool to allow comparability across the country studies, rather than an appropriate target for each country.

Box 6.5 CBD Strategic Plan 2011-2020

Strategic goal C: *To improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity*

Target 11: By 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscape and seascapes.

This is a global target and no specific national 'target effort sharing' has been elaborated.

Source: http://www.cbd.int/sp/targets

Georgia is the only country that has a protected area target that exceeds the CBD target of 17%. Most other countries would need to increase their current coverage considerably to reach it, and go beyond their intended targets. The greatest increase in protected area coverage would be for Russia. However, it is clear that increases in protected area coverage would particularly benefit the biodiversity-rich Caucasus region, the peatlands of Belarus and the wetlands and steppe lands of Ukraine.

It is important to note that the percentage of a country designated as protected areas does not provide a reliable indication of the adequacy of the proportion protected (as this will vary according to the ecological / biodiversity value of the country), the ecological coherence of the protected areas as a network, the level or effectiveness of protection given to biodiversity within protected areas, or the degree to which positive management measures are undertaken within them. Also many countries have important biodiversity resources outside their protected area networks, which may be conserved to varying degrees through various instruments in the wider environment.

It was beyond the scope of this study to assess the effectiveness of protected area management in each country, and, as with protected area coverage, up-to-date data are difficult to obtain. Nevertheless, several of the country reports noted that the management of protected areas could be improved, through for example:

- Development of clearer and more coherent biodiversity conservation policies, with improved cooperation between different governmental departments and other bodies that influence biodiversity.

- Stronger legislation that is consistent with biodiversity conservation policies.

- Production of management plans for protected areas.

- Increased funding for protection and management, for example to increase protected area staff, (e.g. to help prevent illegal activities, prepare manage plans, work with local communities to support sustainable activities and carry out scientific research and monitoring) and support beneficial management actions and restoration works (such as control of invasive species).

- Improved training and capacity-building for governmental employees, and other services that support nature conservation.

- Improved biodiversity and socio-economic information bases on which to base decisions, through the development of targeted research and monitoring programmes.

- The development of greater environmental awareness of the potential social and economic benefits of protected areas, especially their role in supporting local communities.

6.2.4 Benefits of improving biodiversity protection – qualitative assessment

Numerous studies, such as the MEA and TEEB assessment have shown the value of biodiversity in terms providing ecosystem services (see section 6.1 above) and a summary of those that are likely to benefit from increasing protected area coverage is provided in Table 6.2 below (further details of potential benefits relating to the protection of forests is provided in the section 6.3). However, the benefits of such services have been infrequently and incompletely studied in the countries covered by this study. Furthermore, the benefits provided by each protected area will vary considerably depending on its context, such as its ecosystem type and condition, and the need for its potential ecosystem services (globally and locally). It has therefore not been possible to reliably quantify the benefits of increasing protected area coverage in each country or calculate their monetary value.
However, those services that are likely to benefit most from the protection of terrestrial and freshwater ecosystems in the region (from the information that was supplied in the country studies, and other studies such as the MEA) are highlighted in the table below.

The assessments indicate that the most important benefits of increasing protected area coverage in the region are likely to be related to the protection of carbon reserves (especially in the peatlands of Belarus), the improvement of raw water resources in terms of quality and quantity (through better protection and management of vegetation in vulnerable catchments), capturing of pollutants from waste water and run-off (e.g. from agricultural land) in catchments of water bodies that are polluted or vulnerable to further pollution and habitat provision for threatened species. Some significant benefits could arise with regard to cultural services, but it is uncertain to what extent protected areas are needed to maintain such services in the region.

Insufficient information was received from the country studies to reliably assess the contribution that marine protected areas could make to the protection and enhancement of ecosystem services. However, evidence from studies elsewhere, such as in the Mediterranean Plan (Plan Bleu, 2005) have shown that marine ecosystems provide very high economic benefits from, for example, fisheries, tourism and recreation, CO_2 sequestration, waste assimilation and protection of coastlines. Marine protected areas could undoubtedly help to protect and enhance such benefits through the protection of fisheries (e.g. creating sources for stock replenishment) and the safeguard of clean water, nature and landscapes which is fundamental to much coastal tourism.

Key for typical relative importance: + = most likely to increase the service, - likely to result in a decrease in the service H = High, M = Moderate, L = Low, ? benefit is uncertain, V = benefits likely to vary from high to low according to local circumstances, U = unknown.

Table 6.2 Overview of key benefits of increasing protected area coverage

Service	Typical relative importance	Rationale for assessment and related observations
Provisioning services		
Food	-L	Agricultural production may be reduced in some areas, but benefits may arise from more sustainable production in some areas if appropriately managed
Raw materials	-L	As above regarding e.g. timber for construction (but also bioenergy), some potential increases in some products (e.g. reed and sedge)
Freshwater	+M	Likely to improve water quality if protected areas are appropriately protected and managed (e.g. reductions in overgrazing, clear-cutting of forests)
Medicinal resources	+L?	Most species in the region have probably been screened for medicinal benefits, but it is difficult to predict future needs and opportunities.
Regulating services		
Local climate and air quality	+L	Most new protected areas are likely to be outside cities (where small areas of green space can provide such benefits) and others will not be of sufficient size to affect local climates
Carbon sequestration and storage	+M/H	Large areas of peat-rich soil occur in the region (e.g. Belarus – see case study below) and are affected by unsustainable use, which is leading to carbon losses. Significant benefits could arise from sustainable management, although protected area designation may not be necessary, or the best means, for achieving this.
Moderation of extreme events	+M	Improved protection and managements of forests and grasslands, e.g. to reduce clear-felling and vegetation lose, could provide increased protection from landslides and avalanches in mountainous areas, in particular the Caucuses.
Waste-water treatment	+M/H	Many of the water bodies in the region and surrounding areas (e.g. River Danube, Black Sea and Caspian Sea) are highly polluted, especially from nutrients (see Water section above). Maintenance of forest and grassland cover in catchments, and downstream wetlands, could help filter out and capture significant pollutants
Erosion prevention and maintenance of soil fertility	+L	Some areas are overgrazed or subject to clear-felling of forests and therefore prone to erosion, especially in hilly and mountainous regions.
Pollination	+L?	Natural and semi-natural vegetation can provide important habitat for pollinators that can provide benefits for nearby crops. However, the potential gain may be limited because many protected areas are unlikely to be close to large areas of cropland where pollinator populations are depleted to levels that have significant impacts on crops.
Biological control	+L?	Natural and semi-natural vegetation can provide important habitat for predators of pest species that can provide benefits for nearby crops. However, many protected areas are unlikely to be close to large areas of cropland where such impacts could be significant, so as for pollinators, the benefits may be

Table 6.2 Overview of key benefits of increasing protected area coverage		
		low.
Habitat or supporting services		
Habitats for species	+H?	As noted above the relative levels of protected area provision are low in most countries, and therefore an increase to 17% (CBD target) has the potential to significantly improve the conservation of many ecosystems and associated species in the region that are threatened or declining. However, the effectiveness of protected areas will be highly dependent on the level of protection and the implementation of pro-active management. There is currently little information available on the effectiveness of protected areas in the region, therefore there is some uncertainty over the level of potential benefit of simply increasing protected area coverage.
Maintenance of genetic diversity	+M?	Some scope for using traditional breeds of livestock to manage protected areas, as these are often most suitable for grazing semi-natural habitats. But needs and opportunities are uncertain.
Cultural services		
Recreation and mental and physical health	+M?	There are well documented benefits from outdoor recreation etc., but the maintenance of green space is not highly dependent on protected area designations, and most recreation benefits are not clearly linked to levels of biodiversity within them.
Tourism	+M?	Many protected areas, especially in scenic locations, are major tourist attractions. However, most tourism is related to landscape quality and not closely linked to biodiversity (except for a few iconic species, e.g. Brown Bears, pelicans in the Danube Delta). It is uncertain to what extent landscape quality is widely threatened in the region or what the potential for tourism growth is in new protected areas, therefore the added value of increasing protected area coverage is uncertain.
Aesthetic appreciation and inspiration	+M?	As noted above, many protected areas are of very high aesthetic value, however, the need for increased protection of areas in the region to maintain such values is uncertain.
Spiritual experience and sense of place	V	Such benefits will be highly context specific, with some protected areas being of very high value, whilst others (especially artificial habitats) may have no spiritual value

Box 6.6 Case Study : Benefit assessment of Russian National Park 'Lake Pleshcheevo'

The national park 'Lake Pleshcheevo' was established as a Russian Federal nature protected area in 1988. The National Park (Fig.6.2) occupies 15,271 hectares of forest lands, 5,963 ha of lake, 554 hectares of agricultural lands as well as 2002 hectares of other lands. The total area of the national park is 23,772 hectares. There are 16 species of fish, with some rare species among them, such as the European whitefish, also called 'the royal herring'. There are 790 species of plants, 9 of which are listed in the Red Book of Russia. The park has 60 species of wild animals, some are endangered, such as roe deer, flying squirrel, shrew-baby, muskrat. There are also 210 species of birds, with such rare species as the gray heron, gray goose, whooper swan and gray crane. The park has 26 archaeological monuments, 2 monuments of history
The national park provides ecosystem services to the town and nearby areas. However the value of these has not been taken into account in decision making. Undervalued nature protected areas make them uncompetitive and therefore under-budgeted for their maintenance. To address the imbalance of evidence on the values of land, the benefits from the national park conservation was calculated (Sitkina 2010, see Russia country report for full range of refernce), both in qualitative and quantitative as well as monetary terms. The table below presents a summary of the direct use and non-use values. This demonstrates very important benefits in water provision and mushroom picking (provisioning services) in flood prevention and carbon storage (regulating services), recreation (cultural services) and habitats.

Figure 6.2 A map of the national park 'Lake Pleshcheevo'

Table 6.3 The Value of Ecosystem Services provided by the National Park 'Lake Pleshcheevo',

Direct Use Value, thou Euro	
Timber	18 – 31.5
Wild berries	86.9 – 134.4
Forest mushrooms	2737 - 4195
Fish	60.8 – 98.8
Water	1500 – 2400
Tourism	187.5
Sub-Total	**4590.2 – 7047.2**
Indirect Use Value	
Carbon sequestration	496.2
Flooding prevention	1757.2
Habitat for wildlife	761.2
Human recreation	1863.2
Wetland cleaning services	94.3
Sub-Total	**4972.1**
TOTAL	**9562.3 – 12019.3**

Sitkina, K (2010 a and b)

6.3 Deforestation levels

6.3.1 Introduction

The benefit assessment on this subtheme on deforestation looks at the benefits of avoided deforestation (where applicable), which have to be seen in the context of the current forest cover and benefits, and the trend in loss/gain of forest coverage. While forest loss and the loss of carbon storage and the wider range of ecosystem services is an issue for all countries (at least at a local level). At a net national level deforestation is an issue in only a subset of ENPI countries.

For a range of countries there has been a significant growth of forest coverage that is has led to a growth in carbon storage and hence a contribution to climate change mitigation. Given the importance of climate change and the site specific nature of many of the above services, this study has focused primarily on carbon storage value of forests to help illustrate a value of forests and the importance of addressing deforestation (see further below on wider ecosystem services).

This parameter measures the annual change in the area of forested land. Change is measured as the number of hectares (ha) increase or decrease in forested land and as the percentage increase or decrease in the area of forested land[30]. The overall assessment of change includes both forest loss due to removal of trees and forest gain due to replanting. It should be noted that a net zero loss in forest cover (replanting the same area as is deforested in a given year) may not necessarily lead to no net loss of value to the country, as the stock and flow of products and services from the lost forest and gained forest are often different.

Forests play an important role in the global carbon cycle for their ability to absorb carbon dioxide and store carbon in biomass. While forests serve as a net carbon sink, deforestation and forest degradation can be a substantial source of greenhouse gas emissions. The issue of carbon storage (stock) and sequestration (flow) is gaining in global prominence which will

[30] A range of common definitions have been used in this study. National statistics may in some cases used the same ones, and yet in others slightly different ones; there may be some differences therefore for some of the numbers in this report to some national reports – in the ENPI national assessments where there is a clear difference these are noted to help avoid confusion:

Forest: Land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 percent, or trees able to reach these thresholds *in situ*. It does not include land that is predominantly under agricultural or urban land use. (FAO, 2010)

Other Wooded Land: Land not classified as 'Forest', spanning more than 0.5 hectares; with trees higher than 5 meters and a canopy cover of 5-10 percent, or trees able to reach these thresholds *in situ*; or with a combined cover of shrubs, bushes and trees above 10 percent. It does not include land that is predominantly under agricultural or urban land use. (FAO, 2010)

Deforestation: includes activities such as conversion of forest to agricultural land, conversion for urbanisation, illegal logging *etc.* Forest may also be degraded by fire, pests and storms which can lead to their eventual loss. When considering factors driving deforestation, the likelihood of these degradation factors increasing/decreasing should also be considered.

lead to increasing market/payments for avoided carbon emissions from deforestation and forest degradation (Karousakis et al 2011). The quantitative and the monetary assessment focuses on these benefits, i.e. on the value of carbon stored in forest biomass, as this is perceived as a figure easy to understand and communicate to policy makers/the wider public. The quantitative assessment focuses on benefits in terms of the quantity of carbon captured by the existing forest, as well as the potential avoided loss in case of reduced deforestation. As for the monetary assessment, the value of the benefits related to the carbon captured by existing forest today and in the future (potential for sequestration) has been estimated using a high and low € value for carbon, based on recent literature.

It should be kept in mind, however, that the biodiversity value of forests goes well beyond their capability of storing carbon, and is intrinsically related to their flora and fauna and the quality of the habitat, which could not be taken into account in our calculations. Forests in fact provide multiple functions, including goods and services such as timber, food, fodder, medicines, provision of fresh water, soil protection, cultural heritage values and tourism opportunities – leading to significant environmental, health, social and economic benefits (MA 2005,TEEB 2008, 2009a; 2009b,2010; 2011) – Box 6.7 presents a range of examples to illustrate the value of forests; there have been very few studies in the ENPI East region, hence the examples are from third counties). Furthermore, forests are also important for the conservation of species, habitats and genetic diversity, which have a value in their own right ('intrinsic values'), irrespective of the benefits that they provide to human populations. Qualitative insights on the broader set of benefits have been noted to complement the analysis when information was available.

Box 6.7 Forest Ecosystem Services – seeing the whole picture.

Forests in different forms cover an area of around 4 billion hectares2 (30.3 per cent of total global land area) and contain 80 to 90 per cent of the world's remaining terrestrial biodiversity (Costanza et al, 1997, see also FAO, 2000). They provide many valuable goods and services, including timber, food, fodder, medicines, climate regulation, provision of fresh water, soil protection, carbon sequestration, cultural heritage values and tourism opportunities (Shvidenko et al, 2005, TEEB 2010, 2011). It has been estimated that around 1.1 billion people depend on forests for their livelihoods (Vedeld et al, 2004; UN Millennium Project, 2005) and that 1.6 billion people around the world depend to some degree on forests for their livelihoods (World Bank, 2004).

Forests as a carbon sink: Standing forests are an important net carbon sink. Old-growth tropical forests are estimated to absorb up to 4.8Gt CO_2 per year, equivalent to around 0.67t CO_2 per capita (IPCC, 2007; Eliasch, 2008; Lewis and White, 2009). Globally, carbon stocks in forest biomass decreased by an estimated 0.5Gt a year in 2000 to 2010, mainly due to a reduction in total forest area (FAO, 2010). This is assumed to amount to approximately 15 per cent of annual human-induced CO_2 emissions. Conversely, deforestation releases CO_2, into the atmosphere and, at current rates, may account for 18 to 25 per cent of global CO_2 emissions (Stern, 2006; UNEP 2009).

Wider ecosystem services: as noted above forests have value not just for their provision of food, fibre and fuel, their contribution to climate regulation (by carbon storage, sequestration, and effects on local climates), but also for a wide range of services that can be reduced with degradation or loss in conversion / deforestation. Also new forests will generally have lower service provision than loss old growth forest, and mono culture plantation forests can have a very restricted range of services. Examples of values of forests are noted below. As there are few studies in the ENPI East area (which itself could usefully be addressed), a range of other examples are noted - to illustrate the benefits.

Service	Value
Food, fibre and fuel	Provisioning services for Cameroon's forests (per hectare average discounted net present values) were estimated at US$560 for timber, US$61 for fuelwood and US$41–US$70 for non-timber forest products (NTFPs) (Lescuyer, 2007, based on a review of previous studies). Tribal communities living in the Rajiv Gandhi National Park derived 4691 rupees per household per year from NTFPs (Ninan et al, 2007).
Climate regulation	Value of climate regulation by tropical forests in Cameroon at US$842–US$2265 per ha (Lescuyer, 2007, based on a review of previous studies). Value of carbon stored in above-ground biomass in Guyana's forests, estimated at between $6500 and $7000 per ha at $20 per tonne, but could rise to over $20,000 per ha at potential values of $60–80 per tonne in near future (Office of the President Republic of Guyana, 2008).
Water regulation	Value of flood protection by tropical forests in Cameroon estimated at US$24 per ha/year (Yaron, 2001).
Groundwater recharge	Contribution to groundwater recharge of a 40,000ha tropical forest watershed in Ko'olau, Hawaii, estimated at (net present value (NPV) using shadow prices) US$1.42–2.63 billion (Kaiser and Roumasset, 2002).
Pollination	Average value of pollination services provided by forests in Sulawesi, Indonesia, estimated at €46 per hectare. Due to ongoing forest conversion, continued decline of pollination services is expected to directly reduce coffee yields by up to 18 per cent and net revenue/ha by up to 14 per cent within 20 years (Priess et al, 2007).
Existence values	A contingent valuation study in the UK and Italy evaluated non-users' willingness to pay (WTP) for a proposed programme of protected areas to conserve Brazilian Amazonia at $US43 per household per year (Horton et al, 2003). The value of natural forest in the Herbert River District, North Queensland, was estimated through choice modelling at AUS$18 per ha/year (approximately US$11) (Mallawaarachchi et al, 2001).
Opportunity cost	The value of land use lost by NOT deforesting, on average, is approximately $1000 per ha (present value over 30 years, Grieg-Gran, 2008), varying with geographical and economic details. The values of ecosystem services lost by deforestation (see above) will very often exceed this. In particular the climate regulation values are likely to be higher. Office of the President Republic of Guyana (2008) suggests that the cost of carbon abatement via side-payments to avoid deforestation would be only $2–11 per tonne of carbon dioxide.

Source: From ten Brink et al (2011a) in TEEB (2011)

For carbon values, we focus on stock values, and note also the value of avoiding potential losses – especially in those countries were deforestation is not currently an issue, but where it will be important to protect and well manage the existing forest in order not to lose its existing value. Overall, the carbon values (See Box 6.8) are here estimated with a relatively simple procedure applicable to all countries, therefore it has not been possible to take into account local specificities and tailored assumptions. The figures provided should therefore be seen as a general illustration of the potential carbon value of forests, providing an order of magnitude rather than a precise estimate, and hopefully offering a useful starting point for future country-tailored analyses.

Box 6.8 Estimating carbon values

There is no single estimate for the cost of CO_2 but rather a range of estimates dependent on what is measured (e.g. cost of achieving a target, or level of damage due to climate change to avoid), the model used and the assumptions made (e.g. level of trading, use of CDM), the type of values taken into account (traded values or non-traded values) and timescale. Care is needed as regards whether the cost of 'carbon' (C) reduction or of 'carbon dioxide' (CO_2) reductions is being quoted. Carbon weighs 12/44 CO_2.

A range of values was used for this ENPI assessment. European Commission values (EC 2008 and DECC 2009) were adopted as the lower value for 2010 and 2020, and the values from a study by the French Centre d'Analyse Stratégique (2009) as the upper range. These are summarised in the table below. These were considered to provide a fair range that also reflects work in the UK, World Bank and other estimates (see second table). These values are higher than the current values in the EU-ETS market. While at first sight this could lead some to argue that lower carbon values should be used, it should be noted that the benefits of action to address climate change are fundamentally linked to avoided damage; the current carbon market prices are considered significantly below the expected marginal damage costs, therefore using them would lead to a potentially significant underestimate in the benefits of addressing climate change. Indeed, even the use of costs of action lead to underestimates of the benefits of action.

For the project, common carbon values were adopted across all countries. These were applied in different parameters: for emissions savings from increased RES and from methane capture, and from avoided emissions from deforestation and degradation. The former two areas are generally in the domain of traded emissions; for degradation and deforestation this is still under debate/negotiation. For the sake of simplicity and without suggesting that carbon saved from avoided deforestation and degradation would be traded and fungible with other carbon, a common CO_2 value was used.

Table 6.4 Carbon value used in this study (€/t)

GHG	Range	2010	2020
Carbon dioxide (CO_2) or CO_2 equivalent	Low	€ [illegible].2	€ 39
	High	€ [illegible]	€ 5[illegible]

Table 6.5 Range of values for CO_2 from international studies (a selection)

	Date	2009 GBP	€/tonne CO_2
New Carbon Finance	May-09	36.8	46.1
DB Researc[illegible]	May-09	34.9	43.8
Barcl[illegible]s Capital	May-09	28.	3[illegible]1
Société Général[illegible]	May-09	27.3	34.2
European Commission	IA 2008 (for 2020)	31.	39.0
DE[illegible] (UK)	Latest: core	25.1	31.5
	low	14.2	17.8
	high	31.3	39.3
French government	value for 2010		32
	value for 2020		56

EC (2008; DECC (2009); and Centre d'analyse stratégique (2009).

6.3.2 *Current status in the region*

Forest cover in the ENPI East (ENP East + Russia) region as a whole is at almost 48 % of territory; the highest level is in Russia both in percentage coverage terms (nearly 50%) and particularly in area coverage (809 million hectares). Coverage in Belarus and Georgia also very high in terms of share with both around 40% coverage. In terms of area covered Ukraine has the second largest forest coverage (nearly 10 million ha), despite a lower share (just under 17%)[31] (see Table 6.6, Figure 6.3; and Box 6.9).

Figure 6.3 Forest Cover

http://www.foresteurope.org/filestore/foresteurope/Publications/pdf/state_of_europes_forests_2007.pdf

Deforestation is currently an issue (at a net national level) only in Armenia and Georgia. In Moldova and Belarus and to a lesser extent Ukraine there has been net increase of forest area, afforestation. This does not mean that deforestation is not an issue at all, as on a local level a loss of forest can lead to loss of important ecosystem services for the local level. Also replacing old growth forests with new growth can lead to losses of services (including carbon storage). Table 6.6 presents the net change in forest area; see the country reports for more details on what is behind these numbers (see Box 6.9 for Russian example giving deforestation and afforestation issues).

Table 6.6 Forests coverage and change in coverage 1990 to 2010

	Level of forest coverage 2010		Past Forest cover - 1990	Net change in forest area 1990 to 2010	Net deforestation (afforestation) rate (p.a. 1990-2010)
	% of territory	Hectares	Hectares	Hectares	%
Armenia	9.29%	262,000	270,000	-8,000	-0.15%
Azerbaijan	11.33%	936,000	936,000	0	0.00%
Belarus	42.53%	8,630,000	7,780,000	850,000	0.52%
Georgia	39.46%	2,742,000	2,779,000	-37,000	-0.07%
Moldova	11.74%	386,000	316,000	70,000	1.01%
Russia	49.40%	809,090,000	808,950,000	140,000	0.001%
Ukraine	16.75%	9,705,000	9,274,000	431,000	0.23%
ENPI East	47.88%	831,751,000	830,305,000	1,446,000	0.01%

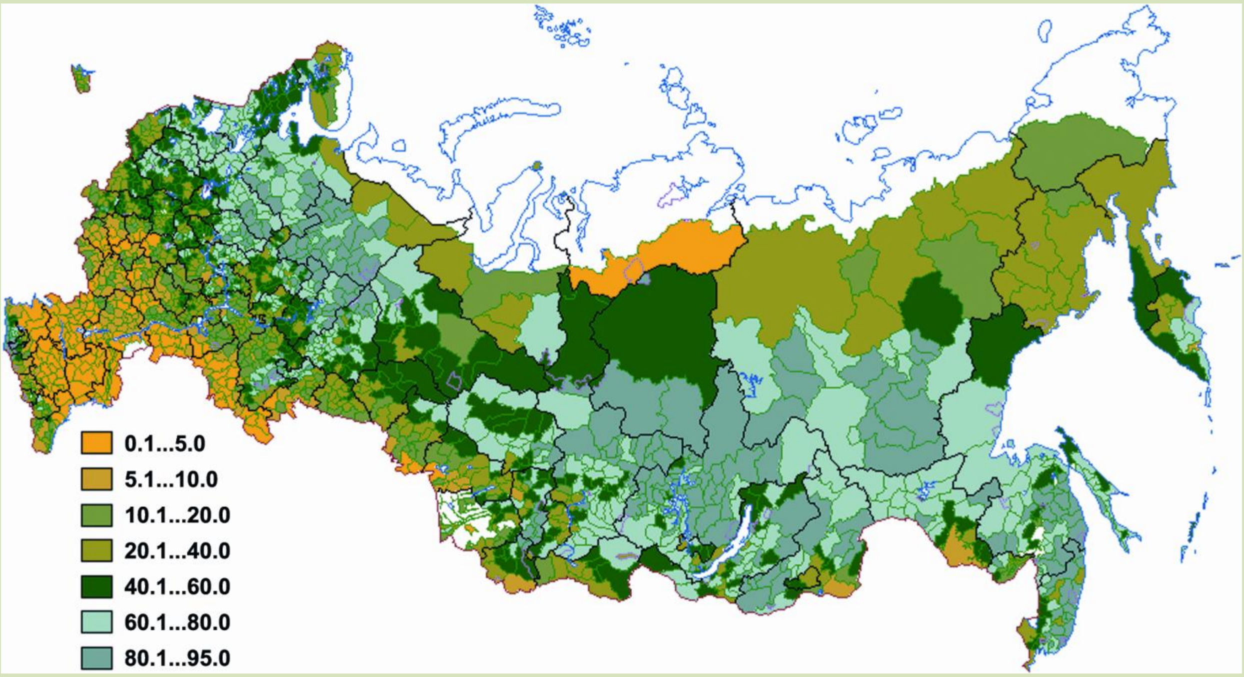
Source: own calculations based on http://www.fao.org/docrep/013/i2000e/i2000e.pdf

[31] OPT value has been estimated at 1.5% but the data appear less robust.

Box 6.9 Forestry coverage, deforestation and afforestation in Russia

Russia is very rich in forest resources. 26% (3,448 km2) of virgin forests in the world is concentrated in Russia. Forest area is estimated as 46.6% of the land (see map), and increased by 8.8 million hectares during the last 10 years. Total forest reserves are 82 billion m^3, since 1993 they increased by 2%. Existing forest reserves fully cover domestic demand.

Figure 6.4 Forest cover in Russia.



Source: see Russia country study: *Perelet, R. and Solovyeva, S. 2011.*

There is an overall increase in forest area in Russia, with however, regional/local deforestation issues. Deforestation issue is extremely regional in nature, is relevant for areas around key urban agglomerations, along the border in West and Far East of Russia, mining regions. Location specificity is key to determining the status of forested land lost or gained in time. |Factors that bring about deforestation, include:

- Illegal logging which has a high collateral environmental impact, and is estimated at around 35 percent of all logging in European Russia and 50-70 percent in the Russian Far East and the Caucasus,
- Geological exploration, mining,
- Forest fires, which affect up to 2 million ha annually,
- Exposure to harmful organisms

Table 6.7 Deforestation by factors

	2000	2002	2003	2004	2005	2006	2007	2008
Deforestation – total 1000 ha	777,5	361,3	630,8	436,9	988,2	311,1	319,3	273,4
including:								
forest fires	709,7	304,3	540,4	149,5	465,5	174,9	200,2	170,7
adverse weather conditions	38,2	21,2	18,2	62,9	461,9	56,7	56,7	36,9
anthropogenic factors	2,0	3,0	3,0	2,5	5,3	7,5	14,8	17,4
exposure to harmful organisms – total	27,7	32,7	69,2	221,8	55,5	72,1	47,5	48,5
including:								
damage by harmful insects	20,5	22,0	56,1	206,5	33,6	31,0	24,0	28,8
damage by wild animals	1,5	0,3	0,5	0,4	0,3	0,4	0,2	0,2
other groups of pests	5,8	10,5	12,5	14,9	21,6	40,6	23,4	19,5

Source: 'Environmental Protection in Russia 2008.' Federal State Statistics Service - M., 2009.

As regards reforestation: the table below give the rates. Reforestation take place mostly natural and partly 'artificial' (plantations), 20-30% of total reforestation area.

Table 6.8 Reforestation in Russia

	Reforestation, 1000 ha		
	total	Artificial reforestation	
		total	% of all reforestation area
2000	972,9	263,3	27,1
2002	886,8	254,3	28,7
2003	834,1	233,1	27,9
2004	796,7	230,4	28,9
2005	812,3	187,1	23,0
2006	877,3	194,5	22,2
2007	872,5	202,4	23,2
2008	828,4	191,4	23,1
2009	837	181	22

Source: 'Environmental Protection in Russia 2009.' Federal State Statistics Service - M., 2010.

Forests perform a range of functions – while all have multiple ecological functions and offer a range of ecosystems services, a range have been designated specifically for specific purposes, e.g. production (particularly in Russia, Belarus and Ukraine), for the protection of soil and water (particularly in Azerbaijan and Georgia, and also Armenia). A range of forests are also designated for the conservation of biodiversity (e.g. as related to protected areas as noted in the previous section) – up to 14% in Belarus and 17% in Moldova (see Table 6.9). The many designations underline the points made above as regards multiple eco-system services from forests. The protection of soil and water is not surprisingly an important rationale for designation – as forests have important water storage, provisioning and purification functions (MA 2005, TEEB 2010, TEEB 2011).

Table 6.9 Forests primary designated functions

Function	**Production**	**Protection of soil and water**	**Conservation of biodiversity**	**Social services**	**Multiple use**	**Other**	**None or unknown**
Area (%)							
Armenia	24	46	0	0	30	0	0
Azerbaijan	0	92	8	0	0	0	0
Belarus	50	19	14	18	0	0	0
Georgia	0	79	8	13	0	0	0
Moldova [32]	0	10	17	26	0	47	0
Russia	51	9	2	2	10	26	5
Ukraine	46	31	4	19	0	0	0

http://rainforests.mongabay.com/deforestation/

32 In Moldova under 'other' we have 'Forest having the designated function as protection against extreme climatic manifestation and industrial influence'

Box 6.10 Georgia and the Caucasus

Forests cover about 2,742,000 ha, i.e. approximately 39.5% of the Georgian territory. In addition to the high coverage rate, 97% of forests are natural (as opposed to plantation), and have high conservation value. Another positive feature is that they are found in almost all regions of the country. Around 10% of forests are within protected areas and special protection is afforded to riparian forests and sub-alpine forests outside of protected areas. Georgia's forests constitute a crucial element of the Georgian natural environment, rural livelihood, cultural tradition and national economy. They are important for the provision of ecosystem services including soil protection, water regulation and climate stabilization. They are also of critical international importance, as a habitat to many endemic and endangered plants and animals, and as a factor of the regional climatic and water regime.

Unfortunately, several anthropogenic factors threaten biodiversity and lead to a drastic reduction in forest quality and density and a decline in species composition. These factors include unsustainable, intensive logging, unsustainable firewood harvesting, hay production in forest areas, fragmentation of forest, illegal hunting (increasing, due to socio-economic reasons and lack of enforcement of nature conservation legislation), and generally a lack of public awareness and recognition of environmental degradation as a major issue of concern. Natural threatening factors include pests and diseases (spread at almost entire territory) and forest fires.

Because of forest destruction in the Caucasus, landslides of catastrophic character have become frequent phenomena since the 1980s. Along with this, a reduction of surface and ground water reserves has been observed in different parts of the Caucasus, which is again connected with intensive wood cutting. Despite the fact that more recent trends indicate a decrease in illegal extraction of forest resources, the felling of trees for timber and firewood remains one of the key threats to biodiversity. With sustainable management, the forestry sector could increase its contribution to the national economy while also better ensuring sustainable provision of ecosystem services (such as watershed management, control of erosion and flooding), conservation of landscape and biodiversity, and the opportunity for recreation and tourism.

Source : building on information from http://www.carbonfix.info/HAP

6.3.3 Potential environmental improvements

In order to assess the benefits related to forestry, an ENP study wide 'no net loss by 2020' target was set (to allow comparability across nations). As noted earlier, this target is inspired by the commitments made at the recent CBD-COP10 in Nagoya Japan in 2010. As noted in the CBD Strategic Plan Target 5:

> *By 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasibility brought close to zero, and degradation and fragmentation is significantly reduced.* (CBD 2010; see also ten Brink et al 2011b)

This ENP wide target calls for a reduction in the annual incremental reduction of the current deforestation rate to 0 per cent by 2020. The analysis therefore aims to identify the benefits that achieving this reduction can bring.

If the target is met, the rate of deforestation will gradually fall until it reaches 0 in 2020. Although some forest will be inevitably lost in the next decade, its size will decrease at a lower rate than the current one, and finally stabilize in 2020.

The impacts in terms of avoided carbon emissions, and the equivalent monetary values, are assessed in the next chapters.

6.3.4 Benefits of reducing deforestation/conserving forests – qualitative assessment

While the benefits of reducing deforestation, and indeed of avoiding deforestation or degradation of forests tend to be very site specific and dependent on the interactions between the forest ecosystems and the social and economic infrastructures/systems (see country reports for examples as well as TEEB 2010, 2011), there are generally some common benefits from forestry (even if the scale/extent of these depends on context). These are given in Table below and complement the earlier discussion on ecosystem services.

Table 6.10 Overview of key benefits of sustainable forest management

Health benefits	Forests promote health and well-being through their use for recreation and relaxation.

Environmental benefits	A number of environmental benefits are associated with forest land. Forest eco systems have significant ecological functions, in particular soil and water protective, anti-erosion, climate regulating and conservation functions. Benefits include:
	o provision of habitat for animal species diversity and ecosystem. For example, forest coverage provides valuable habitat for endemic species
	o regulating services, such as:
	    o provision of clean air/ carbon storage: forests iimprove air quality, especially in the summer when air quality is often compromised, by lowering temperatures, filtering dust, and absorbing ozone, carbon monoxide, sulphur dioxide, nitrogen oxides, airborne ammonia, and heavy metals and by releasing oxygen. The carbon sequestration mitigates the negative effects of climate change,
	    o soil protective and water regulating functions are often critically important:
	        o protection of agricultural land against soil erosion: the washing out of fertile soil can result in significant damage to agriculture.
	        o water conservation: Forest soils are more absorbent than agricultural soils because of higher organic matter content, and tree trunks, branches and leaves intercept as much as half of the precipitation falling on the forests in Georgia play an important water conservation role. By slowing the rate at which rainwater runoff flows to surface water bodies, so that it can be absorbed into the ground, forests help filter pollutants and sediment from waters (quality improvement) while replenishing aquifers (and thus a drinking water source) and keeping annual stream flows steady.
	        o flood control: forest reduce flooding and low flow events by intercepting runoff and encouraging infiltration
	    o coastal protection.
	o Supporting services:
	    o Soil improvement: The plants enrich the soil by recycling the nutrients through the shedding of leaves and seeds.

Economic	– Forests sustain livelihoods: forests provide wood and non-wood products that

Table 6.10 Overview of key benefits of sustainable forest management	
benefits	are used and marketed especially by rural communities that, due to their economic situation, are forced to secure their food supplies by growing their own vegetables, keeping livestock, fishing and hunting. Specific examples include the provision of: – timber – non-wood forest products, such as game, berries, nuts, mushrooms, fruits of wild plants and medicinal plants: – Carbon trading: Economic benefits may arise from carbon trading as increased forest area could enhance the carbon sink provided by the national forest area. The level of enhancement will depend on the type, age and additional area of forest conserved. Large areas of degraded farmlands could be reforested and used as green investment under the Kyoto Protocol. – Tourism/recreation revenues: Tourism could constitute an important form of forest use in Georgia, but should be developed in a sustainable manner. Political conflicts strongly reduced tourists flow in the country.Well managed forests attract visitors and hence increase revenues from tourism/recreation. – Job creation: management of forest for amenity provision or biodiversity conservation generates employment opportunities. – Forests increase property values.
– Social benefits	– Benefits here include provision of amenity for recreation, education (forests provide outdoor classrooms), tourism, cultural heritage. – Forests provide an opportunity for healthy community action and involvement

The ENPI country study offer a range of national insights on the wider set of benefits – a local case from Russia was presented in the Biodiversity section above, and for the box below presents an example from Ukraine.

Box 6.11 Case example: Ukraine

With sustainable management, the forestry sector in Ukraine could more than double its contribution to the national economy while also better ensuring sustainable provision of ecosystem services (such as watershed management, control of erosion and flooding), conservation of landscape and biodiversity, and the opportunity for recreation and tourism. In addition, Ukraine can capture additional international financing for afforestation in the context of Kyoto Protocol related green investment schemes and Joint Implementation Projects.

Source: Forestry Sector Note, 2006

6.3.5 Benefits of reducing deforestation/conserving forests – quantitative assessment

ENPI east's forests contain just over 34 thousand million metric tons of carbon in living forest biomass, according to 2010 estimates (see tables below), equivalent to almost 125 thousand million tCO_2. According to 2010 estimates, the 'average hectare' of forest stores on average 41[33] tonnes of carbon on average for the region, i.e. 150 tonnes of CO_2 – the

[33] We assumed that the average per hectare storage capacity has not changed throughout the years, hence assuming the 2000 carbon stock value remains valid today.

actual level will naturally vary significantly from site to site, and also with general variations across nations depending on the bio-climatic conditions and state of forestry. Note also that significant levels of carbon are also found in the soil and litter, so these carbon values used here should be seen as a conservative figure. In the event of deforestation or degradation it is not only the living carbon that can be released but also the 'dead carbon' - in other words if the trees are cut down then not only is the carbon stored in the trees lost (unless used in construction) and become CO_2 (directly if burnt for fuel), but also the carbon in organic material in the soil (as this can be oxidised by soil disturbance) can be lost and eventually also methane (an important greenhouse gas) where currently 'captured' in the ground (MA 2005, TEEB 2011, Keith et al 2009). Note that this 'nuance' is in fact quite a vital one, as the soil carbon can be as big as the 'living carbon' and there are also vast quantities of methane (a powerful greenhouse gas) captured in the soil (in Russia) - deforestation, degradation of climate change would each potentially lead to significant methane release and hence an increase in global warming. The table below gives the current levels of carbon stored and what it equates to in 'avoided CO_2'.

Table 6.11 ENPI East forest Carbon

	Level of forest coverage 2010		**Carbon storage (living carbon) per hectare**	**Carbon storage (living carbon) per hectare**	**CO_2 stored in forest stock (living carbon)***	**C stored in forest stock (living carbon)* in**
	% of territory	Hectares (thousand)	tC/ha	tC02 equiv. /ha	mtC 2010	mt CO_2 equiv. 2010
Armenia	9.29%	262	48	176	13	46
Azerbaijan	11.33%	936	58	213	54	199
Belarus	42.53%	8,630	71	260	613	2247
Georgia	39.46%	2,742	77	282	211	774
Moldova	11.74%	386	75	275	29	106
Russia	49.40%	809,090	40	147	32364	118667
Ukraine	16.75%	9,705	78	286	757	2776
ENPI East	47.88%	831,751	41	150	34040	124814

Note: Ratio of C to CO_2 given my relative molecular weight 12 to 44. In other words 1 tC = 3.67 tCO_2.
Source: FAO data.

Forests, like many other ecosystems are affected by climate change, both negatively and positively. Forests also have the ability to affect global climate and climate change. This effect can be due to both increased reflection or increased absorption of heat into the atmosphere depending on the other land cover (e.g. if more open and soil covered forests can absorb less, and if compared to snow covered areas in northern latitudes it can absorb more).

Forests also help in local cooling, which can be important for local climates (e.g. cities) but this is not likely to have a global climate effect. Another effect can be due to forest's role in the global carbon cycle that affects global climate change. Forests absorb carbon in wood, leaves and soil (carbon sinks) and release it into the atmosphere when the trees decay or if they burned, during forest fires or the clearing of forest land (Source of Carbon emissions).

According to the FAO 2010 report, the world's forests store more than 650 billion tonnes of carbon, 44 per cent in the biomass, 11 per cent in dead wood and litter, and 45 per cent in the soil. This is a global average, and there is a very large variation across land use types, forest types across the world.

The table below gives some ENPI specific ranges – again averaging for the country as a whole. However, for this assessment we limit ourselves to what is stored in forest biomass and for the living biomass for which data available in the FAO. The ENPI East region contributes very substantially to this global total, particularly given the Russian forest contributions to global carbon stocks.

Table 6.12 Carbon content in ENPI countries: average per hectare values (all land types)

Country	Vegetation carbon (t/ha)	Soil carbon (t/ha)	Litter carbon (t/ha)
	1961-1990	1961-1990	1961-1990
Armenia	30	107	17
Azerbaijan	15	78	9
Bulgaria	33	76	10
Belarus	68	133	24
Georgia	54	116	20
Moldova	43	94	15
Russia	51	201	33
Ukraine	37	91	14

Source: Haxeltine, A., and I. C. Prentice (1996)

Further to this The Economics of Ecosystems and Biodiversity (TEEB) shows that to halt forest degradation and deforestation is an integral part of both climate change mitigation and adaption when focusing on 'green carbon'. Forests are further useful to preserve due to their huge range of services and goods they provide to local people and the wider community (TEEB, 2009; TEEB 2010; TEEB 2011; MA 2005).

As noted above, meeting the ENPI wide target of halting deforestation by 2020 will (at a net level) only be a relevant target for Armenia and Georgia – with the potential to avoid the emissions of about 4.4 million tonnes of CO_2 from lost living forest biomass. Had deforestation been halted at 2010 levels abruptly, rather than gradually, the carbon benefits would have been higher – 6.3 $mtCO_2$.

These numbers are quite small compared to the reality for ENPI East as a whole, given the large scale of the forests, but are nevertheless significant.

As noted above this analysis cannot pick up the fact that there is deforestation (e.g. locally) but that this is not picked up on a net national level. The loss of old forests which have been shown to be very important carbon stores (and generally wide set of ecosystem services) is rarely offset by new growth – i.e. a net zero deforestation does not necessarily mean a net zero carbon or ecosystem service balance.

Were the analysis would have been able to pick up local deforestation issues and do a separate analysis for losses and gains, the benefits of avoiding deforestation (carbon from living biomass, loss of soil carbon, loss of range of services (and indeed also degradation of forests) would have been larger.

Table 6.13 Comparative assessment for million tonnes of CO_2 stored under BAU and target scenarios. In million tonnes of CO_2 (mtCO_2)

Year	CO_2 stored (million tonnes) in living forest stock - 2010	BaU: 2020 – if 1990-2010 trend continued to 2020	Projected Change mtCO_2	Target 2020: halting deforestation trend in 2020	Net saving from halting deforestation	Net saving relative to 2010 reference point
Armenia	46.1	45.4	-0.7	45.9	0.5	0.7
Azerbaijan	199	199	0.0	n/a	n/a	n/a
Belarus	2247	2366	119.5	n/a	n/a	n/a
Georgia	774	769	-5.2	773	3.9	5.2
Moldova	106	117	11.2	n/a	n/a	n/a
Russia	118667	118677	10.3	n/a	n/a	n/a
Ukraine	2776	2839	63.8	n/a	n/a	n/a
ENPI East	**124814**	**125013**	**198.9**	**n/a**	**4.4**	**6.3**

Source: Own Calculations based on http://rainforests.mongabay.com/deforestation/2000/Georgia.htm adapted from (FAO, 2011a).

6.3.6 Benefits of reducing deforestation/conserving forests – quantitative assessment

By using a monetary (high and low) value for carbon, as identified in recent studies, it is possible to monetise the value of the amount of carbon currently stored in the forests' living biomass, as assessed above.

Assuming a value of CO_2 of 17.2 €/ton (low) and 32 €/ton (high) in 2010, the value of the carbon currently stored by the ENPI East forests ranges between 2 to 4 thousand billion € (see later point on stock and marginal values). This is the estimate of the value of the carbon stored in the living biomass today in ENPI East.

By 2020, the stock of carbon in living biomass - assuming projected carbon values of 39€/ton (low) and 56€/ton (high) – would suggest values of between nearly 5 and 7 thousand billion €. In Georgia and Armenia, under the halting forest loss by 2020 target, between 170 and 250 million € of potential carbon losses could be avoided. This is summarised in table 6.14 below.

In other ENPI countries, the 'halting deforestation target' does not apply when looking at the net national totals, hence to underline the benefits of forests as carbon store an estimate has been made of the projection in carbon value from the continued growth of forests – this has been estimated to lead to a carbon gain of 6 to 8.6 thousand million € for the ENPI East region.

Table 6.14 Estimated value of carbon storage in 2010 and 2020 (high and low estimate)

	CO_2 stored in forest stock (living carbon)* mtC02	Value of carbon storage * 2010 € million (stock value)		Value of carbon storage * 2020 *with trend in forest cover and forest carbon from 1990 to 2010 continued to 2020 and with 2020 carbon prices* € million (stock value)		Value of halting deforestation - avoided CO_2 emissions from stock loss to 2020 € million (change in value of carbon stock)		Value of continued gains in carbon storage - if historic trends continue till 2020 € million (change in value of carbon stock)	
	2010	Low @17.2 €/tCO_2	High @ 32 €/tCO_2	Low @ 39 €/tCO_2	High @56 €/tCO_2	Low @ 39 €/tCO_2	High @56 €/tCO_2	Low @ 39 €/tCO_2	High @56 €/tCO_2
Armenia	46	793	1,476	1,792	2,573	20	29	n.a.	n.a.
Azerbaijan	199	3,424	6,370	7,763	11,147	n.a.	n.a.	n.a.	n.a.
Belarus	2247	38,643	71,894	88,765	127,458	n.a.	n.a.	3517	5051
Georgia	774	13,316	24,773	30,142	43,280	151	217	n.a.	n.a.
Moldova	106	1,826	3,397	4,245	6,095	n.a.	n.a.	330	474
Russia	118667	2,041,064	3,797,329	4,628,095	6,645,470	n.a.	n.a.	300	431
Ukraine	2776	47,741	88,820	108,866	156,321	n.a.	n.a.	1870	2685
ENPI East	124,814	2,146,806	3,994,058	4,869,668	6,992,344	171	246	6,018	8,641

Source: own calculations based on FAO (2011) data

Beyond this indicative example, the benefits of afforestation have not been explored in this study, and the values will vary depending on whether the afforestation is 'natural afforestation' or 'plantation forests'. Both in principle (depending on approach) can be beneficial in terms of carbon storage and also for other ecosystem services such as soil and water retention. The wider range of biodiversity benefits and ecosystem service benefits will depend on the approach – natural afforestation tends to offer greater biodiversity benefits and wider mix of eco-system services than plantations. Ideally afforestation would adopt sustainable practices, taking into account the implications for other neighbouring habitats (e.g. avoiding the introduction of invasive alien species) and, to the extent possible, by using native rather than imported species.

Note that this is a stock value and not an annual value of carbon sequestered[34], so care is needed when looking at carbon savings from renewable energy technologies, which offer savings every year (see later section). Note also that these values are total values; strictly speaking the carbon values applied are more suited to marginal changes than total stock values (as if all stock were to be lost, the marginal value itself would change); nevertheless the calculated values are important as indicators of the climatic importance of not losing the forest cover.

6.4 Level of land degradation

6.4.1 Introduction

Agricultural crop land degradation is widespread in many countries of the world including in the ENPI countries. Benefits of a reversal of crop land degradation or, in other words, an improvement in cropland quality are assessed in this section.

A target for improvement in cropland quality to be achieved by year 2020 is specified, direct and indirect benefits of crop land improvements are discussed qualitatively, and direct benefits in terms of increased value of crop production are quantitatively assessed.

Definitions of key terms used are presented in Box below.

34 Annual carbon sequestration from existing forest stocks depend on a number of features (maturity, type of forest, whether living and non-living carbon are included, management practices, climatic conditions) – these have not been calculated separately for each country; the FAO statistics that formed the basis of this analysis gave carbon stock values.

Box 6.12 Definition of key terms - cropland

Crop land: Land used for cultivation of agricultural crops.
Area harvested: Hectares of crop land multiplied by the number of harvests per year.
Crop yields: Tons of crop harvested per hectare of area harvested.
Crop production: Tons of crops harvested, i.e., area harvested multiplied by crop yield.
Cereals: Mainly wheat, barley, maize, rice, oats, sorghum, rye and millet.
Other crops: Fruits, vegetables, fibre crops, oil crops, pulses, roots and tubers, treenuts and other minor crops.
Crop land quality: those characteristics and properties of crop land that affect crop yield. Crop land quality is impaired by crop land degradation and potentially improved by improved crop land management.
Crop land degradation: Inter-temporal changes in properties of crop land such as loss of top soil (from wind and/or water erosion), soil salinity, soil nutrient losses and other degraded physical or chemical properties of the soil.
Human induced degradation: Degradation caused by human activities.
Improved crop land management: practices that reduce, prevent, or reverse crop land degradation and preserve or improve crop land quality with positive impacts on crop yield.

6.4.2 Current status in the region

Agriculture share of GDP in the ENPI East countries averaged about 10 per cent in 2008, ranging from 6 per cent in Azerbaijan to 18 per cent in Armenia. Area harvested was about 82 million hectares. Cereals constituted 72 per cent and ‘other crops’ 28 per cent of total area harvested, but area harvested of ‘other crops’ was as large as that of cereals in Georgia. Area harvested per capita ranged from about 0.1 hectares in Armenia and Georgia to 0.45-0.5 hectares in Moldova and Ukraine (see table below).

Table 6.15 Area harvested and agricultural share of GDP, 2008

	Area harvested (million ha), 2008			**Area harvested (ha/capita), 2008**	**Agricultural share of GDP, 2008**
	Cereals	Other crops	Total		
Armenia	0.18	0.11	0.29	0.09	17.8%
Azerbaijan	0.90	0.40	1.30	0.15	6.3%
Belarus	2.30	1.10	3.40	0.35	9.8%
Georgia	0.25	0.23	0.48	0.11	10.0%
Moldova	0.95	0.70	1.65	0.45	10.9%
Russia	40.00	12.00	52.00	0.37	5.0%
Ukraine	14.30	8.30	22.60	0.49	8.3%
ENPI East	58.88	22.83	81.71	0.29	9.7%

Source: Area harvested is estimated based on linear trends using FAO reported data from 1995-2008 due to annual fluctuations in area harvested (FAO 2011). Agricultural share of GDP is from World Bank (2010) and UN Stats.

Much of agricultural crop land in the ENPI East countries suffers from degradation. But systematic and nationwide data are scarce. One exception is the Global Assessment of Soil

Degradation (GLASOD) survey data presented in FAO (2000).[35] The national territory is classified into five categories: land that is non-degraded, and land with light, moderate, severe and very severe degradation. According to these data, human induced land degradation ranges from nearly 50 per cent of the national land area in Russia to nearly 100 per cent in most of the other countries (Table 6.16). However, 79-100 per cent of the population in the countries lives in or around degraded land. Main identified types of degradation are water erosion and chemical deterioration. Main identified causes of degradation are agricultural activities and deforestation. Box 6.13 provides a further overview of the land degradation problems and its causes in several of the countries.

Table 6.16 Extent of human induced land degradation – agricultural land

	% of national land area			% of population living on or near degraded land		
	Degraded	Light and Moderately degraded	Severely and Very severely degraded	Degraded	Light and Moderately degraded	Severely and Very severely degraded
Armenia	100%	89%	11%	100%	88%	12%
Azerbaijan	97%	40%	56%	98%	40%	57%
Belarus	100%	94%	6%	100%	95%	5%
Georgia	83%	73%	10%	79%	70%	9%
Moldova	100%	0%	100%	100%	0%	100%
Russia	48%	26%	22%	86%	30%	56%
Ukraine	99%	22%	76%	99%	17%	82%

Source: FAO (2000).

Box 6.13 Land degradation in some of the ENPI countries

Armenia

Bad land management is one of the main pressures causing soil degradation and having an impact on food security, and tourism and other sectors. Farmers are not managing their practices and do not receive adequate guidance on the issue. There is a big problem with erosion, contamination and unused land leading to degradation. Ownership of pastures / meadows and high fields has not been identified, and some lands are overgrazed while others are undergrazed. Over the last 50 years, pasture production has decreased with 30%. Regional problems exist in the Valley Ararat where soil has become more salty and alkaline and groundwater tables have risen.

Georgia

The agricultural sector provides over 50% of employment in Georgia. Nearly 35% of agricultural land is degraded to some degree by water or wind erosion, the result of ill use as well as anthropogenic and natural processes. Erosion affects nearly a half of arable land, 570 thousand hectares of pasture and hayfields and 87 thousand hectares in the Black Sea coastal zone. Erosion is a serious problem particularly in mountain areas, and along with natural processes significant contributions come from cultivation of steep slopes, impact from overgrazing, and logging. Desertification in the eastern part of Georgia has intensified because of the overgrazing and climate changes.

35 GLASOD collated expert judgement of soil scientists to produce maps of human induced soil degradation. Using uniform guidelines, data were compiled on the status of soil degradation considering the type, extent, degree, rate and causes of degradation within physiographic units (Sonneveld and Dent, 2007). Sonneveld and Dent (2007) note that the GLASOD data do not necessarily represent consistent classifications of land degradation across countries. Cross-country economic assessments are therefore not necessarily comparable.

Box 6.13 Land degradation in some of the ENPI countries

Moldova

According to the Institute of Soil Science, bad agricultural practices are the main cause of land degradation. Every year, soil erosion expands by about 7,000 ha. There are currently about 112,000 ha at risk of desertification. This is mainly due to the process of privatization of land in 1990's that resulted in very small plots (1-1.5 ha or smaller) often shaped as sloped belts of 20 x 500 m where ploughing only can be done along the slope from top- down-top). Fragmented land is the reason for very low use of modern techniques / equipment in agriculture. Overgrazing of rangeland is another cause of soil erosion.

According to the Institute of Soil Science, the following degradation problems can be identified: 40% of lands are affected by erosion; 600 thousand tons of humus are lost per year, with humus content reduced to about 3% from 5-6% a hundred years ago; there are large losses of nutritional elements (called agrochemical degradation); about 22 million tons of black soil are lost every year, washed away by the rivers into the Black Sea; soil compacting is a problem; and small river plains often suffer from salinisation.

Russia

Desertification, previously regarded in Russia as a regional problem of degradation of Kalmykia Black Lands and the Kizlyar pastures north of the Republic of Dagestan, is now affecting 27 subjects of the Russian Federation. Environmental damage from desertification of agricultural lands of arid zones of Russia is no less than 0.7-1 billion dollars a year over the past 15-20 years. Although desertification affects 7% of the total area of the Russian Federation, about 50% of the population lives in and around these areas producing more than 70% of the agricultural products of the country. According to the Federal Real Estate Cadastre Agency the average loss of grain yield for slightly eroded arable soils is 13%, 44% for average eroded soils, and 60% for severely eroded soils. Danger of erosion is exacerbated by the fact that the processes of erosion are manifested mainly in the major grain producing areas of the Russian Federation.

Ukraine

Next to high cultivation rate exposing Ukrainian soil to accelerated wind and water erosion, the quality of the resource is further threatened by frequently observed unsustainable agricultural practices. With monoculture, deviation from crop rotation measures and heavy use of mineral fertilisers, soil fertility has been steadily decreasing. As such, it is estimated that the humus content of Ukrainian soils decreased by around 20% within the last 100 years. Current loss of fertility progresses at the rate of 0.04% of humus loss in 5 years.

The major causes of land degradation include: Land clearance (in particular deforestation; agricultural depletion of soil nutrients through poor farming practices; inappropriate irrigation; urban sprawl; uncontrolled development of infrastructure; soil contamination from e.g. inappropriately stored agrochemicals, landfills with industrial and municipal waste, and waste water; and land fragmentation from privatization which seriously complicates the implementation of good agricultural practices, impairs the protection of biodiversity and strengthens the many existing land management problems.

The major stresses on land include: Erosion affects 57.5 % of Ukraine's land area; soil contamination around 20 %; acidification 17.7 %; alkalization 3.7 %; and salinization 2.8 %. Soil erosion is thus the most widespread and dangerous soil degradation process in the country. Yearly erosion causes loss of 600 million tons of soil including 20-33 million tons of humus. Current rate of soil erosion in Ukraine under 'normal' weather conditions (without extreme events such as dust storms) is around 15 tons per hectare per year. Wind erosion is in particular severe in the steppe zone of Ukraine characterised by small share of vegetation able to stop strong winds. Water erosion is more prevalent in the mountain areas of Western Ukraine. Some agricultural practices, like planting too large a proportion of row crops (sugar beet, sunflower, etc.), exacerbate the problem. A particular problem constitutes the illegal cutting of protective trees in greenbelts around agricultural lands.

Source: See the ENPI benefit assessment country reports.

6.4.3 Potential environmental improvements

Target to be reached by 2020

The target for which benefits are assessed in this study is an improvement in crop land quality by year 2020 that results in an increase in crop yields equivalent to half of the crop yield losses from current levels of land degradation. Improvement in land quality also has other benefits that are discussed qualitatively (see below).

It is assumed that the improvement in crop land quality as stipulated by the target is achievable through improved crop land management practices that reduce or halt on-farm loss of top soil from erosion, reduce soil salinity, partially of fully replenish soil nutrients, and improve other physical and chemical soil properties.

The GLASOD data are used here to estimate the increase in crop yields from meeting the target in 2020. Such estimation is, however, not free from problems and necessitates many assumptions:

- First, crop yield reductions resulting from current levels of land degradation must be assumed. Plausible reductions applied here are presented in Table 6.17 using a 'low', 'medium' and 'high' scenario.[36]
- Second, the GLASOD data do not allow for crop specific yield effects. It is therefore assumed that all crops cultivated in each land category suffer from the same yield reduction.

In light of the need for these assumptions, the benefit assessment in this section should be considered as only indicative.

Table 6.17 Assumptions of current crop yield reductions on degraded land

Land degradation categories	**Yield reduction (relative to non-degraded land)**		
	'Low	**'Medium'**	**'High'**
Not degraded	0%	0%	0%
Lightly degraded	5%	5%	5%
Moderately degraded	10%	15%	20%
Severely degraded	15%	20%	25%
Very severely degraded	20%	25%	30%

Source: Assumptions by the authors.

Baseline to 2020

Baseline tons of crop production must be projected to year 2020 from reference year 2008, assuming business-as-usual (i.e., no change in crop land management practices). Baseline crop production is then compared against estimated crop production resulting from achieving the target in year 2020 (see above) through better crop land management.

36 The assumed yield reductions for 'moderately degraded' land are of similar orders of magnitude as average yield losses reported in Pimentel et al (1995) and a literature review of several regions of the world by Wiebe (2003).

Baseline projections in crop production from 2008 to 2020 are presented in Table 6.18. Projected annual change is based on linear trends in production of cereals and other crops from 1992 to 2008 using data from FAO (FAO 2011). The projected change in production reflects changes in both areas harvested and crop yields.

Table 6.18 Projected baseline annual change in crop production, 2008-2020

	Cereals	Other crops
Armenia	2.0%	3.0%
Belarus	0.9%	0.2%
Georgia	-1.0%	-4.9%
Moldova	-0.6%	-3.1%
Russia	0.5%	0.2%
Ukraine	1.2%	0.5%

Source: Estimates by the authors.

Projections in real crop prices to year 2020 must also be made in order to estimate the monetary benefit of improvement in crop land quality.[37] It is assumed that real prices of cereals and 'other crops' will increase at annual rate of 4 and 3 per cent, respectively. Crop prices may be expected to increase at a faster rate to 2020 than prices of other goods and services in the economy. The FAO world food price index increased by 33 per cent and the FAO world cereals price index increased by 31 per cent from the 2007-2010 average index value to the January-February 2011 average index value (FAO 2011). However, the large price increases of cereals and foods observed during 2006-2008 and again in 2010 are likely to be off-set by future periods of decline in prices as experienced during 1999-2003 and again in 2009. Thus the projected real price of cereals is assumed to increase at a rate of 4 per cent per year and the real prices of other crops at a rate of 3 per cent per year to 2020. The crop prices in reference year 2008 to which these price increases are applied are FAO reported international commodity prices for cereals and FAO reported producer prices for other crops in each of the countries.[38] International commodity prices for cereals are applied because they better reflect the real economic value of internationally traded crops, such as cereals, than domestic producer prices of these crops.

Improvements achieved by reaching the targets

The improvements of reaching the target by 2020 are the difference between crop land quality with no change in crop land management practices and crop land quality with improved land management practices. This difference is assumed to result in an increase in crop yields equivalent to half of the crop yield losses from current levels of land degradation (*see Target to be reached by 2020*). Improvements in crop land management practices may also be expected to have many other benefits (see below).

The GLASOD data do not map crop areas harvested by the categories of land degradation in table 2. Assumptions about distribution of crop areas harvested must therefore be made.

37 Real crop price increase is nominal crop price increase minus the nominal price increase of other goods and services in the economy.

38 Reference year cereal prices are averages for 2007-2010 to smooth the price volatility observed in 2008.

Two distribution options are used here:

1. Crop areas harvested are distributed in proportion to land area in each land degradation category.
2. Crop areas harvested are distributed in proportion to population distribution across the land degradation categories.

The first option assumes that crop area harvested is uniformly distributed across the country. Clearly this is a special case and highly unlikely because of forests, mountains and uncultivable desert/arid areas. The second option assumes that hectares of crop area harvested per population are the same everywhere. This may be close to the case if the whole population were rural and employed in agriculture.

Estimates of yield increases from meeting the target in 2020 are presented in Table 6.19.[39] 'Low', 'medium' and 'high' refer to the scenarios of yield losses from land degradation in table 6.17. The largest expected yield increases are in Moldova and Ukraine.

Table 6.19 Estimates of yield increase from meeting the target in 2020

Country	low	medium	high
Armenia	4.9%	7.0%	9.2%
Azerbaijan	6.2%	8.3%	10.7%
Belarus	4.6%	6.7%	8.8%
Georgia	2.9%	3.4%	3.9%
Moldova	8.9%	12.6%	16.8%
Russia	4.5%	6.0%	7.7%
Ukraine	9.0%	12.6%	16.7%

Source: Estimates by the authors.

6.4.4 Benefits of reducing cropland degradation – qualitative assessment

Improvement in crop land management resulting in improved crop land quality and reversal of crop land degradation has many direct and indirect benefits including health, environmental, economic and social. Direct benefits are those that accrue on-farm, such as increased crop yields and long-term sustainability of land use. Indirect benefits are those that accrue off-farm, such as benefits from reduced soil and agro-chemical run-offs. A generic overview of these benefits is provided in Table 6.20 (e.g., see also CDE 2009).

[39] Yield increases from meeting the target in 2020 is first estimated for each of the two distributions of crop areas harvested, using the data in tables 2-3. The mean of the yield increases of the two distributions is then used for the benefit estimation of meeting the target.

Table 6.20 Benefits of improved crop land management

Health benefits	– Soil erosion control can reduce agro-chemical run-offs which can help reduce pollution of water sources used for drinking and bathing, and thus contribute to protection of health. – Improved soil nutrient management can reduce the need for chemical fertilizer applications and thus reduce nitrate pollution of surface and groundwater resources used for drinking.
Environmental benefits	– Soil erosion control can reduce soil run-offs and sedimentation of rivers and lakes. Sediment: ○ causes turbidity in the water that limits light penetration and prohibits healthy plant growth on the river bed. ○ can cover much of a river bed with a blanket of silt that suffocates life. ○ is an important carrier of phosphorus, a critical pollutant which causes eutrophication. – Soil erosion control and improved soil nutrient management can reduce the need for and run-offs of agro-chemicals and thus reduce water pollution. – Improved crop land management can prevent land becoming degraded to the extent that it is abandoned (e.g., severe erosion or salinity, physical or chemical soil degradation). Thus, in some countries, improved land quality can contribute to reduced desertification.
Economic benefits	– Improved crop land management enhances agricultural crop yields through improved physical and chemical soil properties and reduced salinity and erosion. – Erosion control reduces sedimentation of reservoirs and dams used for irrigation, municipal water supply, and/or hydropower, and therefore increases their useful lifetime. – Reduced agro-chemical run-offs from erosion control may also reduce the cost of municipal water treatment.
Social benefits	Erosion control reduces agro-chemical run-offs and therefore improves quality of water bodies used for recreation.

Source: Produced by the authors.

6.4.5 Benefits of reducing cropland degradation - Quantitative assessment

Many of the benefits of improved crop land management are difficult to quantify, such as health, environmental, and off-farm economic benefits. The quantitative assessment focuses therefore on the on-farm value of increased crop yields from improved crop land management. The economic benefits of reduced dam and reservoir sedimentation are especially important in water scarce counties. The social benefits of improved recreational values from reduced agro-chemical pollution of water resources are reflected in the benefit assessment section on surface water quality.

The benefits of meeting the target of improvement in land quality that reduces current crop yield effects of land degradation by 50 per cent by 2020 are estimated based on the yield increases in Table 6.19. The yield increases are multiplied by the estimated value of crop production in 2020. This provide the estimated value of the extra tons of crop production as a result of reducing land degradation and are the annual benefits in 2020 of meeting the target.

6.4.6 Benefits of reducing cropland degradation - Monetary assessment

The estimated benefit, in terms of improved crop land quality and increased crop production, totals about €8.1-14.6 billion (PPP) in year 2020 (Table 6.21). The 'medium' estimate ranges from 0.1-0.15 per cent of GDP in Georgia and Russia to 1.5-2.0 per cent of GDP in Ukraine and Moldova. These two countries with the largest benefits as a per cent of GDP are the countries with the largest estimated crop yield increases from improved crop land management.[40]

Table 6.21 Estimated annual benefits in 2020 of meeting the target

	Benefits (€s, PPP million)			Benefits (% of GDP)		
	Low	Medium	High	Low	Medium	High
Armenia	94	134	177	0.48%	0.69%	0.91%
Azerbaijan	285	385	493	0.33%	0.44%	0.57%
Belarus	583	834	1105	0.51%	0.72%	0.96%
Georgia	17	20	23	0.09%	0.10%	0.12%
Moldova	144	204	272	1.41%	1.99%	2.66%
Russia	3544	4772	6071	0.11%	0.15%	0.19%
Ukraine	3480	4868	6436	1.10%	1.53%	2.03%
ENPI East	8147	11216	14577	0.57%	0.80%	1.06%

Source: Estimates by the authors.

40 A regression analysis finds that about 70% of the variation in benefits as a percent of GDP across the ENPI countries is explained by the countries' estimated crop yield increase from improved crop land management and their agricultural share of GDP.

7 CLIMATE CHANGE

Key messages: Climate change

- **Energy consumption** causes around 2,014 million tCO_2 emissions per year in the region; an average of 9 tCO_2 per capita per year, and a range of 1.1 (Georgia) to 11.2 (Russia) reflecting, reflecting climate, energy resources and infrastructure, economic activity, and social norms.
- **Renewable energy sources (RES) contribute almost 3% of gross final energy consumption in ENPI East** (in 2008). They provide 15,943 ktoe of a total of 549,076 ktoe final energy consumption for the region. The RES share ranges from 1% (Ukraine and Azerbaijan) up to 33% in Georgia (EIA, 2010).
- **Potential for renewable energies:** The increased uptake of renewable energy sources represents a major potential for the region to reduce GHG emissions as well as address energy security, cost issues as well as having a potential to create new employment and driver of the economy.
- In ENPI East the amount of gross final energy consumption from RES, if the ENPI RES target were met, is estimated at 116 mtoe – using a conservative energy conservation baseline.
- An increase of the RES share of gross energy consumption from current levels to 20 per cent is estimated to reduce CO_2 emissions by about 365 million tonnes CO_2 by 2020.
- Assuming a CO_2 value ranging from €39 and € 56 per tonne in 2020, the reduced emission from CO_2 estimated above will represent a saving of between €14 and 20 billion per year in 2020. For the purpose of comparing the results to current money values, if the RES target were to be met today the benefits from reduced emissions would be between € 6 and 11.5 billion /year given lower carbon prices (€17/t and €32/t in 2010).

Climate impacts and adaptation:

- A significant and accelerating trend in mean temperature has been identified in this region. An increase of 0.41^{0}C per decade was observed for the period 1979 to 2005. By the end of the current century it is estimated that an increase of up to 5.5^{0}C may occur. Over this century rainfall patterns are likely to change, resulting in dryer summers but more extreme rainfall events resulting in increased flood risks.
- These trends in climate are projected to result in a wide variety of impacts across sectors in the region. Whilst agricultural crops may benefit from enhanced CO_2 fertilisation effects, over time these are thought likely to be outweighed by water constraints and flooding that both reduce crop productivity.
- The most common impacts identified across the region are i) constraints on water resources arising from changing rainfall patterns combined with higher rates of evapotranspiration; ii) heat wave-related health impacts associated with respiratory

Key messages: Climate change
and cardio-vascular conditions, and iii) the impacts on infrastructure and other resources as a result of river flooding. • The potential impacts of climate change on ecosystems and biodiversity, agriculture and coasts are also recognised as being significant. • The recognition that climate change is occurring and is likely to continue has led to a wide variety of adaptation measures being considered to combat this range of potential climate change impacts. Emphasis is being put on adapting to projected water resource constraints in order to provide security of supply to domestic and industrial users as well as agricultural producers. • Both man-made technological solutions and ecosystem based adaptation approaches (working with nature to adapt to climate change) should be explored on an equal footing and in light of wider benefits.

7.1 Overview

All regions of the world face the risk (in some cases already reality) of important man-made climate change impacts and each region has contributed in some way to this climate change (even if at vastly different levels), had the potential to help avoid climate change and adapt to climate change; two ways of reducing the risks to their region, their countries (IPPC 2007, Stern 2007).

This section presents an overview of the type of impacts (that need avoidance or adaptation) and also the scale of the 'responsibility' (put in terms of GHG emissions), which in turn present a scale of opportunity for avoiding emissions.

Section 7.2 presents an important area of action to reduce emissions – renewable energy sources (RES). A growth in RES contribution to energy supply and consumption can lead to significant levels of avoided GHG emissions, and is an integral part of the transition towards a low carbon economy, a critical thread of the wider ambition and need of moving towards a green economy (UNEP 20110, OECD 2011).

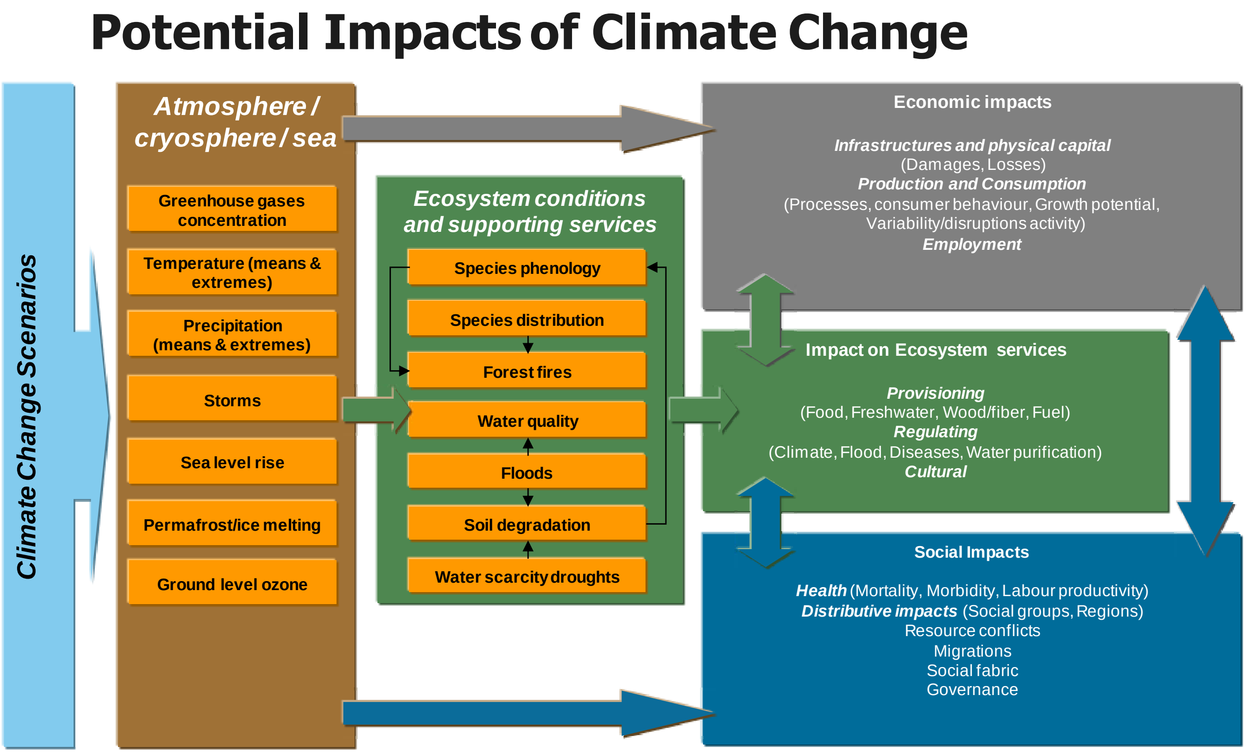
Other important areas of GHG emissions reductions and hence climate mitigation include 'methane capture' from waste landfills and carbon storage and sequestration in forestry – as in chapters 5 and 6 of this report. There is also significant carbon stored more widely in natural capital, whether 'green carbon' (e.g. agricultural soils, grasslands) or blue carbon (e.g. carbon in seas, wetlands) – and measures in these areas will be important for a move to a low climate economy (see TEEB 2010b). Furthermore, there is a vast need for improved energy efficiency in buildings, in transport, in products and process. Actions in each of these areas together stand a chance of mitigating climate change and keeping to the (average) 2 degrees rise that has been proposed as the 'acceptable maximum'.

Even this 'acceptable maximum' is achieved, there will be important risks and important losses and societies will need to adapt to these change. A 2 degree rise may well be too late for many warm water coral reefs (TEEB 2010), but a wide range of adaptation measures can be made which will offer benefits to nations. Section 7.3 presents the issue of climate change impacts, risks and adaptation needs for the region.

Climate change impacts

Figure 7.1 presents an overview of potential impacts from climate change (see Figure 7.1). Climate change will not just be about increased GHG concentrations and temperature rises, but also impacts on precipitation levels (including flooding incidence and drought), storms, sea level rise, risks of permafrost melting. This can affect species, forest fires, floods, soil degradation, water availability. There will be impacts on natural capital and the flow of services from this capital, a range of economic impacts and social impacts.

Figure 7.1 Potential Impacts of Climate change Adaptation to Climate Change - Overview



Source: Environment DG based on (EEA, 2008) , OECD 2008 and TEEB. Potential impacts are all impacts that may occur given a projected change in climate, without considering adaptation

Current status of GHG emissions in the region

The total CO_2 emissions from energy consumption in the region amounted to around two thousand million tonnes of CO_2 in 2008, or an average of 9.3 tCO_2/capita. When wider emissions are taken into account, then total emissions are 2841 billion tCO_2 equivalent, with a per capita emissions of 13.1 tCO_2/capita/year. There is a wide range across the countries in the region, reflecting climate, energy resources and infrastructure, economic activity, and social norms.

Table 7.1 CO_2 emissions

	Population	Total CO_2 Emissions from energy use (million tonnes CO_2)	CO_2 emissions per capital from energy supply (TCO_2/cap)	Total GHG Emissions from the economy as a whole (million tonnes CO_2 equiv.)	GHG Emissions per capita ($tC0_2$equiv. / capita per year)
	2008	2008	2008	(Year)	(Year)
Armenia	3,077,087	5	1.7	25.3 (1990)	7. 14(1990)
Azerbaijan	8,680,100	29	3.4	43 (1994)	5.63 (1994)
Belarus	9,680,850	64	6.6	91 (2008)	12.6 (2008)
Georgia	4,307,011	5	1.1	12.2 (2006)	2.8 (2006)
Moldova	3,633,369	7	1.9	11.88 (2005)	3.16 (2005)
Russia	141,950,000	1,594	11.2	2229.6 (2008)	15.77 (2008)
Ukraine	46,258,200	310	6.7	427.8 (2008)	9.3 (2008)
ENPI East	217,586,617	2,014	9.3	2,841	13.1

CO_2 Emissions from energy sources from EIA (2008) and IEA (2010) +
For total GHG and GHG./capita equivalent:
http://unstats.un.org/unsd/environment/air_greenhouse_emissions.htm

The emissions present an indication of the potential scope for measures to reduce emissions. Section 7.2 below presents what benefits are potentially available from increased use of RES and hence avoiding GHG emissions.

7.2 Uptake of renewable energy sources

7.2.1 Introduction

This section focuses on the benefits of increasing the use of renewable energy sources (RES), as these can reduce the amount greenhouse gases (GHG) thanks to the reduction in the consumption of fossil fuels. Whilst the resulting air quality improvements are primarily local and national in scale, the reductions in climate change impacts are assumed to be spread globally. The following definitions apply:

- *Energy from renewable sources:* energy from renewable non-fossil sources, namely: Wind, Solar, Aerothermal (i.e., energy stored in the form of heat in the ambient air), Geothermal (i.e., energy stored in the form of heat beneath the surface of solid earth), Hydrothermal (energy stored in the form of heat in surface water) and ocean energy, Hydropower, Biomass (i.e., biodegradable fraction of products, waste and residues from biological origin from agriculture - including vegetal and animal substances- , forestry and related industries including fisheries and aquaculture, as well as the biodegradable fraction of industrial and municipal waste), Landfill gas, Sewage treatment plant gas, and Biogases. (EC, 2009)

- *Gross final consumption of energy*: the energy commodities delivered for energy purposes to industry, transport, households, services including public services, agriculture, forestry and fisheries, including the consumption of electricity and heat by the energy branch for electricity and heat production and including losses of electricity and heat in distribution and transmission. (EC, 2009) In this report it is calculated as: total final consumption + distribution losses + own use[41].

The quantification assessment will focus on the environmental benefits related to increased substitution of fossil fuels with RES, resulting in a decrease in CO_2 emissions, if a hypothetical target of 20 per cent RES uptake were to be reached by 2020 (based on EU targets). While this target is currently ambitious, there is potential for a much higher level of RES contribution to domestic energy demand in Egypt (and indeed for export) given the insolation levels in Egypt and the area available for solar plant.

To assess the monetary value of reduced CO_2 emissions due to the RES uptake, a range of carbon values, based on well recognised studies[42], have been used – as shown in the table below.

Table 7.2 Carbon value used in this study (€/t)

GHG	Range	2010	2020
Carbon dioxide (CO_2) or CO_2 equivalent	Low	17.2	39
	High	32	56

Source: based on data from EC (2008; DECC (2009); and Centre d'analyse stratégique (2009)

41 The analysis of the benefits of avoided CO2 emissions from increasing the share of RES of the ENPI countries energy mix focuses on total final energy consumption and builds on IEA data for the ENPI countries. Some assumptions as regards conversion losses in the electricity, heat and CHP (combined heat and power) were necessary in the calculations to allocate outputs to fuel inputs. This regional report builds on common assumptions for the countries for energy conversion ratios for different fuel types, adopting a more nuanced approach than in the first analysis presented in the country reports. The RES share values are in places slightly higher than the country reports for this reason. This does not change the overall conclusions as regards CO2 savings and is mentioned here for completeness. Note that the BAM (benefits assessment manual) and the supporting spreadsheet tool available to countries have also been revised using an adjustable set of conversion rates, to offer countries a tool that allows for using more country specific assumptions. Countries wishing to do their own analysis can explore the issue further by adapting their assumptions in light of fuller nuanced country-specific information on the electricity, heat and CHP stock (performance efficiency, losses, age), exports and imports of fuels, energy efficiency and demand changes

42 European Commission values (EC 2008 and DECC 2009) have been used as the lower carbon values and, estimates from a French study (Centre d'analyse stratégique, 2009) as the higher values.

7.2.2 *Current status in the region*

According to EIA data for 2008 (EIA, 2010), the RES contribution to overall gross final energy is currently around 3.9 per cent for ENPI East – it provided 21.2 mtoe of a total of 549 mtoe final energy consumption for the region. The RES share ranges from 1.6% (Ukraine and Azerbaijan) up to 36% in Georgia. Renewable energy share includes both combustible renewable and waste and the 'clean' RES such as solar, wind and geothermal energy.

Table 7.3 RES share in ENPI East

	Population	Total primary energy supply (TPES)	Total Final consumption (TFC) (excl. losses)	Total CO_2 Emissions from energy use (million tonnes CO_2)	CO_2 emissions per capital from energy supply (TCO_2/cap)	current share of RES in TFC 2008	
	2008	2008	2008	2008	2008	ktoe	%
Armenia	3,077,087	2,997	2,213	5	1.7	134	5.9%
Azerbaijan	8,680,100	13,367	7,809	29	3.4	156	1.6%
Belarus	9,680,850	28,145	20,362	64	6.6	1,510	7.7%
Georgia	4,307,011	2,988	2,461	5	1.1	967	33.6%
Moldova	3,633,369	3,150	2,050	7	1.9	87	3.3%
Russia	141,950,000	686,757	435,516	1,594	11.2	16,987	3.6%
Ukraine	46,258,200	136,143	78,665	310	6.7	1,356	1.6%
ENPI East	217,586,617	873,547	549,076	2,014	9.3	21,197	3.9%

Own calculations based on IEA Statistics –e.g. http://www.iea.org/stats/balancetable.asp?COUNTRY_CODE=BY

7.2.3 *Potential environmental improvements*

In order to calculate the baseline situation in 2020 it is assumed that energy consumption will change proportionally with the change in population (i.e., more people, more energy consumed), and that the share of fossil fuels and RES over total final consumption will remain as the actual levels (as a %), unless there are clear indications for a baseline rise (this is explored in the country reports). It is also assumed that by 2020 the same amount (in kilo tonnes of oil equivalent - ktoe) of combustible renewable and waste will remain the same as today. These are of course all assumptions to help arrive at an estimate of the potential benefits that should prove an indication of the potential benefits.

In our baseline, the gross final energy consumption in 2020 if energy consumption stays the same per capita (a very conservative estimate; note some country studies have looked at sensitivities) will be of about 573 mtoe for ENPI East. The gross final energy from RES will be about 20 mtoe or 3.5%[43] for the region as a whole (with significant variations). Note that in

[43] Note there are some differences in the regional average RES share in 2020 wrt 2008 despite the general assumption that the RES share be taken as constant (a conservative assessment) for the energy input mix

the country studies sensitivities on baselines are taken, to allow not just a benefit assessment versus the status quo RES share, but also an incremental benefit as regards baselines. The former (results presented here) useful to underline the benefits of action from today; the latter (with respect to an increasing RES baseline; see country studies), gives benefits of incremental, additional action.

Table 7.4 Baseline in 2020 for energy consumption

	Total Current gross final energy consumption	Current population	Current gross final energy consumption per capita	Estimated gross final energy consumption in 2020	Baseline Gross final energy consumption from RES in 2020	Share of RES over total in 2020
	Ktoe	*million*	*toe/ capita*	*ktoe*	*ktoe*	*%*
Armenia	2,213	3.08	0.72	2,270	**135**	5.9%
Azerbaijan	7,809	8.68	0.90	12,318	**156**	1.6%
Belarus	20,362	9.68	2.10	19,634	**1,513**	7.7%
Georgia	2,461	4.31	0.57	2,664	**970**	36.4%
Moldova	2,050	3.63	0.56	3,362	**87**	3.3%
Russia	435,516	141.95	3.07	452,770	**16,095**	3.55%
Ukraine	78,665	46.26	1.70	83,728	**1,358**	1.6%
ENPI East	549,076	217.59	2.52	576,746	**20,313**	3.54%

To assess the potential environmental improvements, this ‘business as usual’ baseline scenario is compared to a theoretical target of at least 20 per cent of gross final consumption of energy obtained from RES by 2020. This target is inspired by EU Directive 2009/28/EC requiring mandatory national targets for the overall share of RES in gross final consumption of energy of 20 per cent by 2020.

It is understood that this can be an ambitious target to reach by 2020 for some countries and easy for others.

It has been nevertheless useful to provide an estimate of the benefits to be gained from an ideal improvement. For a number of countries a slightly different target was used where the 20% was not perceived as helpful (e.g. Belarus) which has much more ambitious targets.

The environmental improvement consists on the increase in the uptake of renewable energy if the 2020 targets are reached. In ENPI East the amount of gross final energy consumption from RES if the target were met is estimated at 115 mtoe. This represents an increase of about 100 mtoe from the baseline scenario, and leading to an equivalent reduction of fossil fuel consumption. Naturally some of these 95 mtoe will come from existing plans and strategies.

baseline (in the absence of common reliable projections). This is affected by the different country growth rates of energy consumption across the region.

Table 7.5 Reduced amount of fossil fuel use

	Gross final energy consumption in 2020	RES baseline share	RES target share	RES @target s share *(20% unless otherwise noted*	Reduced amount of fossil fuels /increased RES
	ktoe	%	%	Ktoe	ktoe
Armenia	2,270	5.9%	20.0%	454	319
Azerbaijan	9,716	1.6%	20.0%	1943	1,787
Belarus	19,634	7.7%	20.0%	3927	2,414
Georgia	2,664	36.4%	50.0%	1332	362
Moldova	2,652	3.3%	20.0%	530	443
Russia	452,770	3.6%	20.0%	90554	74,459
Ukraine	83,728	1.6%	20.0%	16746	15,388
ENPI East	573,434	3.5%	20.1%	115486	95,172

7.2.4 Benefits of reducing increasing the uptake of RES – qualitative assessment

Environmental benefits: The energy sector has a mixed record regarding the environment, with conventional power plants and traditional fuel use leading to significant air and water pollution. Renewable energy produces no (or very little) pollution, and it can also prevent or reduce land degradation and habitat destruction due to mining and traditional fuel gathering.

Application of renewable energy technology can also have various climate change mitigation and adaptation benefits. Mitigation benefits from the efficient use of RES include:

- avoidance of CO_2 and other GHG emissions (biomass energy though relies on combustion and therefore produces CO_2; its use would not, therefore, alleviate the greenhouse effect),
- reduced consumption of biomass and wood fuel, and thus protection of land cover and reduced likelihood of deforestation, such that important carbon 'sinks' are conserved.

Renewables themselves are non-polluting, while the structures built to harness them can have positive or negative environmental impacts. It is thus crucial to make sure that possible impacts from RES on the local environment are avoided or mitigated, e.g. no deforestation caused by biomass or limited land use change. For example, particularly relevant for Georgia, dams may affect fish migration but which may also create wildlife habitat.

Health benefits: Renewable energy power plants can help reduce urban air pollution by displacing fossil fuelled power plants and their contribution to poor ambient air quality. The resulting improvements in air quality can have important health benefits to urban dwellers, e.g. a reduction in pulmonary diseases. The benefits of improved air quality are discussed earlier in this report.

Social benefits: The main social benefit of shifting to renewable energies is the possibility to provide energy to isolated locations not connected to the electricity grid. Provision of reliable, affordable and environmentally sound energy services to isolated locations broadens their development opportunities, provides income generation and provides social services like education and health care, food security. In fact, for many applications, renewable energy technologies can be the least-cost source of reliable modern energy.

Examples of applications that result in income generation include:

- water pumping for irrigation
- cottage industry like sewing, weaving, handicrafts
- agro-industry processing
- crop and meat drying and freezing

Examples of applications that provide valuable social services include:

- water pumping for drinking: the use of mechanized pumps can allow to access previously untapped water supplies. As such, improved energy access from renewable energy strengths adaptation and resilience to climate related stresses, i.e. vulnerability to water scarcity
- treating water resources: improved energy availability can allow treating (boiling, filtering, etc.) the available water resources to make them safe for drinking.
- home, school, and community-centre lighting
- community street lighting

Another social benefit of shifting to renewable energies is the possibility to prevent electricity outages and sharp price increases, although large investments for RES might well reduce this benefit.

Furthermore, contributing to mitigating climate change will be beneficial for the wellbeing of citizens living in cities more exposed to sea level rise and will help avoiding relocations.

Economic benefits: An increased uptake of RES can contribute to the energy security of the ENPI East countries, in particular given the dependence of several countries (e.g. Ukraine, Georgia) on (Russian) imports. Renewable energy systems broaden the portfolio of options for energy resources and for reducing dependence on fuels with significant price volatility and availability concerns. In the long-term, hydrocarbon supplies are becoming costlier to discover and extract, pushing up the price. In the medium-term, oil and natural gas prices have been shown to be the most volatile of all energy commodities, and an overexposure to this volatility could harm the economy. Diversification away from fossil fuels could mitigate the impacts of both future price rises, and of volatility, thereby increasing overall energy security. Renewable energy's low recurrent input costs mean that its marginal cost of production is much less exposed to commodity price fluctuations. Therefore, renewable energy systems, by broadening the portfolio of energy resources used within a country, can contribute to energy security and economic stability.

Renewable energy systems can support decentralized markets and contribute to local economic development by creating employment (e.g. for production, installation and maintenance), introducing new capital and innovation, and developing new revenue sources for local communities.

Renewable energy systems can lead to possible cost savings in energy production. For example, wind energy in some areas may turn out to be cheaper than renovating/building new power plants). Renewable sources of energy vary widely in their cost-effectiveness and in their availability and cost savings should thus be evaluated on a case by case level. Although water, wind, and other renewables may appear free, their cost comes in collecting, harnessing, and transporting the energy. For example, to utilise energy from water, a dam must be built along with electric generators and transmission lines.

7.2.5 Benefits of reducing increasing the uptake of RES – quantitative and monetary assessment

An increase of the RES share of gross energy consumption from 3.9 per cent to 20 per cent is estimated to reduce CO_2 emissions by about 345 million tonnes CO_2 by 2020 – see table below.

Assuming a CO_2 value ranging from €39 and €56 per tonne in 2020, the reduced emission from CO_2 estimated above will represent a saving of between €13 and €19 billion per year in 2020.

For the purpose of comparing the results to current money values, if the RES target were to be met today the benefits from reduced emissions would be between €6 and €11 billion year given lower carbon prices (€17 and €32/t in 2010).

Table 7.6 Value of CO_2 reduced emissions – avoided emission in 2020 and carbon values for 2010 and 2020

	Reduced amount of fossil energy use if target met in 2020	Reduced amount of CO_2 emissions if target met in 2020	CO_2 value in 2020 (€/tonne CO_2)		Monetary benefit € million/year in 2020 (2020 values)	
	Mtoe	mt CO_2	low	high	Low	high
Armenia	0.32	0.89	39	**56**	35	50
Azerbaijan	1.79	5.48	39	**56**	214	307
Belarus	2.41	8.42	39	**56**	328	471
Georgia	0.36	1.01	39	**56**	39	57
Moldova	0.44	1.22	39	**56**	48	68
Russia	74.46	264.18	39	**56**	10,303	14,794
Ukraine	15.39	64.32	39	**56**	2,509	3,602
ENPI East	95.17	345.53	39	**56**	13,476	19,350

The monetary assessment focuses on the benefits related to the decrease in CO_2-emissions. The total annual monetary b enefits from reduced emissions due to increased uptake of RES has been estimated at between 13 and 19 billion euro for the year 2020 based on the lower and higher carbon price scenarios and relative to the baseline that has RES growing from 3.9% to 20% over the period. The benefits over the period 2010 to 2020 would start and increase as progress is made to the 2020 target. After 2020 the renewable share will continue to lead to benefits of avoided CO_2 savings over the operational lifetime of the technology and further investments in RE technology.

Box 7.1 Interpreting the Results

These results can be seen as a relatively 'quick scan' or scoping analysis with the aim of deriving a value that could be a useful indication of the scale of potential benefits achievable.

The numbers have been conservative on the side of the expectation of energy demand growth – as we have used population figures. And they have been conservative as well as regards the use of the baseline as regards RES share. **A more detailed and fuller analysis would likely have overall higher CO_2 savings from RES that the above results,** given that energy demand was likely to understated by more than the RES share in 2020 was understated. Countries can naturally derive their own results by factoring their assumptions as regards population changes, GDP changes, energy efficiency gains, structure changes to the economy, energy supply and demand mix and hence overall energy demand, as well as shares of RES growth in the plan, in likely implementation and hence what benefit there are from RES plans, and what potential there are beyond this.

7.3 Climate change adaptation

7.3.1 Introduction

This section identifies benefits from adapting to climate change. The overall objective is to identify potential impacts from climate change (recall Figure 7.1), before identifying measures – known as adaptation – that may be expected to reduce these impacts, and so provide benefits. The emphasis is on climate change impacts that are likely to be detrimental – rather than beneficial - to human well-being.

It should be noted that many of the benefits identified and assessed in this report for other parameters, are common to this section. For example, water resources may be further threatened under climate change futures. In this case, measures that alleviate pressure on water resources are also likely to reduce climate change-induced water resource pressure. However, since climate change exacerbates the pressure, it is implied that to fully respond to the pressure, additional economic resources will be needed.

Adaptation can be defined as adjustment in natural or human systems in response to actual or expected climatic change or its effects. The purpose of the adjustment is to reduce harm- or risk of harm - or to exploit beneficial opportunities associated with climate change. Various types of adaptation can be distinguished, including anticipatory (before impacts are observed) and reactive (after impacts have been felt) adaptation, private and public adaptation, and autonomous (action from individuals, households, businesses and communities) and planned (the result of deliberate policy decisions) adaptation. In most circumstances, anticipatory planned adaptations will incur lower long-term costs and be more effective than reactive adaptations.

Adaptation measures are practical initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects, such as raising river or coastal dikes moving human settlements out of flood plains, the substitution of more temperature-shock resistant plants for sensitive ones, etc. Some are man-made technological solutions (e.g. building dikes or sea walls), others are ecosystem based adaptation measures (making use of natural flood plains; or investing in resilience of ecosystems, including protected areas[44]).

Adaptation benefits are the avoided damage costs or the accrued benefits following the adoption and implementation of adaptation measures. One can distinguish between potential impacts and residual impacts. Potential impacts are all impacts that may occur given a projected change in climate, without considering adaptation. Residual impacts are the impacts of climate change that would occur after adaptation.

Different countries and systems have different adaptive capacity, i.e. a different ability to adjust to climate change or to cope with the consequences. Adaptive capacity is often assumed to relate closely with: level of economic development (GDP/capita); availability of technologies, infrastructure, institutions and education. Vulnerability depends on climate change exposure, sensitivity, and adaptive capacity.

7.3.2 Current status in the region

The main impacts of climate change are projected to occur on human and natural systems in future decades. Consequently, this environmental theme is understood to have more relevance when considering future time periods rather than the present day. However, there is some evidence from the ENPI East countries that weather patterns in recent years have changed in ways consistent with those expected under current climate change scenarios for future time periods. For example, in Azerbaijan, the mean temperature over the last 30 years has increased by 0.34^0C (see also Box 7.2 given a wider picture of climate changes), whilst in Armenia the mean temperature has increased by 0.34^0C over the last 80 years. The frequency of extreme weather events, particularly flooding, has also increased in recent decades.

[44]The UN Framework Convention on Climate Change (UNFCCC) recognizes the value of ecosystem resilience (Article 2) and introduced the term 'ecosystem-based adaptation' at its COP14. (TEEB 2011). Better-managed, better connected, better-governed and better-financed PAs are recognized as key to both climate change mitigation and adaptation. (TEEB 2011)

Box 7.2 Climate changes risks to Azerbaijan

According to forecasted scenarios, the yearly mean temperature increase from 2021 to 2050 will drive a total temperature increase of around 1.50°C--1.60°C. Temperature increases within the first half of the 21st Century will equate to approximately 0.30°C every 10 years. Precipitation will increase by 10--20%, relative to levels during the period 1961--1990. Azerbaijan is likely to suffer a number of critical impacts due to climate change. Principal among them are:

- **Sea level rise**: Azerbaijan's Caspian Sea coastline is vulnerable to fluctuations in water levels forecast under a changed climate, particularly the Absheron Peninsula, the most populated region of the country.
- **Water resource availability and scarcity**: availability is forecast to drop by around 25% under most climate change scenarios, and associated desertification and forest fires are likely to increase in frequency and extent.
- **Increased risk of flooding**: both inland and along the Caspian Sea coast, increased frequency of high intensity precipitation events, as well as fluctuations in sea levels, can be expected to drive damage to property and farmland and potential loss of life. Current estimates for the economic damage of floods are around US$18-25 million annually, but this is likely to increase under climate change.
- **Increased frequency and severity of high temperature events**: most significant in urban heat islands, extreme heat events can cause widespread illness and mortality, particularly among vulnerable groups such as infants and the elderly. Increased average temperatures will assist in the spread of disease, particularly malaria.

Source: Azerbaijan Country Study by James Spurgeon, Emily Cooper and Beaudry Kock (ERM) together with Rafig Verdiyev (National Expert)

Given that the emphasis is on future climate change, the project has surveyed expert judgement in ENPI countries as to their views on the most important climate change impacts likely to affect these countries. The findings of this survey are summarised in Table 7.7 and 7.8. Whilst it should be emphasised that the differences in the depth of information available in each country precludes the findings from individual countries from being compared in detail, the table does serve to highlight common themes within the region. First, it is clear that there are a wide range of climate change impacts identified in all of the ENPI countries arising from changes in climatic means and variability, (temperature and precipitation), as well as sea-level rise. Second, the most common impacts identified are i) constraints on water resources arising from changing rainfall patterns combined with higher rates of evapotranspiration; ii) heat wave-related health impacts associated with respiratory and cardio-vascular conditions, and iii) the impacts on infrastructure and other resources as a result of river flooding.

With regard to i), it was recognised that climate change is likely to exacerbate existing, and growing, pressures on water resources resulting from economic development.

With regard to ii) and iii), it seems likely that this impact was highlighted partly as a consequence of these countries experiencing such events in recent years – 2001 and 2010, respectively.

For these two risks it is interesting to see that they are highlighted in the same five countries – Armenia, Azerbaijan, Georgia, Moldova and Russia – in the Southern part of the region. It should also be noted that in the majority of countries the potential impacts of climate change on ecosystems and biodiversity, agriculture and coasts are explicitly recognised as being significant.

7.3.3 Benefits of climate change adaptation – qualitative assessment

A sample of the variety of benefits of adopting adaptation measures in the region include those listed in Box below.

Box 7.3 Qualitative description of benefits of adaptation to climate change

Environmental benefits	Description
Ecosystem condition improvements	Development of protected corridors for species migration is being promoted on a regional basis. Pro-active forest management strategies are being developed to protect the diversity of wood species and composition of forests; as well as the accessibility of forests for population recreation purposes and the role of forests in fire control.
Health benefits	Description
Lower incidence of acute health impacts	The introduction of heat warning systems in urban areas should be effective in reducing the mortality and morbidity consequences of vulnerability to heat-waves. Disease monitoring systems may be used to contain the spread of vector-borne diseases that may spread as a consequence of flood events or changes in temperature vectors.
Social benefits	Description
Improved quality of life	Reduced health effects Investments in water, soil and coastal restoration for adaptation purposes may help to improve community well-being and provide new opportunities for employment and recreation.
Economic benefits	Description
Protect current production.	Adaptation to the threats to agricultural yield from water scarcity, through more efficient management practices would result in some protection of farm incomes and local economies. It has also been suggested that increased application of fertilisers may also support yield levels, though they are costly and may result in pollution of water courses.
Exploit new opportunities	Increase in tourism and associated expenditures in local areas. These tourism benefits will be realised if, for example, coastal protection and management reduces the threat to coastal amenities

In Tables 7.7 and 7.8 below, the coverage of benefits to climate change adaptation, as highlighted in the survey undertaken, is summarised by country. It is very important to emphasise that the survey asked the national teams to highlight only a small number of climate change risks, and adaptation benefits, likely to be of most significance in the short-term. Thus, the results tables below do not pretend to be comprehensive in their identification of all notable climate change risks in individual countries.

Mirroring the pattern identified in Table 7.7, it is clear from Table 7.8 that a wide variety of adaptation measures are already being considered to combat the range of potential climate change impacts. The survey finds that five countries are recognising the importance of adapting to projected water resource constraints. Adaptation measures that are identified are principally in the form of investments in supply and storage infrastructure that increase the efficiency with which water resources can be exploited. These investments would be targeted at domestic and industrial users as well as agricultural producers. The survey also finds that the majority of countries are concerned with the need for greater levels of flood protection. Again, engineering-based solutions – in this case dykes - dominate those adaptation measures being considered in these countries.

There are also important opportunities for ecosystem based adaptation – working with natural capital to adapt to climate change. This can be cost-effective and can also have useful co-benefits though wider ecosystem service provision and there is arguably more scope for these than the current plans would suggest (see Box 7.4 below).

Box 7.4 Ecosystem based adaptation

We cannot solve biodiversity loss without addressing climate change and vice versa. We therefore need to look for the 'triple win' of biodiversity that can actively contribute to climate mitigation and adaptation. (ECCHM, 2009). The UN Framework Convention on Climate Change (UNFCCC) recognizes the value of ecosystem resilience (Article 2) and introduced the term 'ecosystem-based adaptation' at its COP14.

Climate adaptation on the ground cannot and should not be solely addressed through human-made infrastructure (see for example CBD AHTEG, 2009; Campbell et al, 2009; TEEB 2011): on the contrary, climate-resilient development should include ecosystem-based adaptation where appropriate. Well-designed coherent networks of appropriately managed and ecologically connected PAs are one of the most cogent responses to climate change and should be an explicit component of an ecosystem-based adaptation strategy (e.g. Kettunen et al, 2007).

Ecosystem-based approaches can be applied to virtually all types of ecosystems, at all scales from local to continental, and have the potential to reconcile short- and long term priorities (see for example, Blumenfeld et al, 2009). Green structural approaches – e.g. ecosystem-based adaptation – contribute to ecosystem resilience. They not only help to halt biodiversity loss and ecosystem degradation and restore water cycles, but also enable ecosystem functions and services to deliver a more cost-effective and sometimes more feasible adaptation solution than can be achieved solely through conventional engineered infrastructure. Such approaches also reduce the vulnerability of people and their livelihoods in the face of climate change. Many pilot projects in this area are under way (see TEEB 2011 and World Bank, 2009). The experience gained needs to be mainstreamed across countries and regions.

Ecosystems needing special attention in this respect are wetlands and other freshwater ecosystems (e.g. Palmer et al, 2009), forests (e.g. Bonan, 2008) and agricultural systems, where the link between climate change, ecosystem services and human livelihoods is explicit. Agricultural productivity is affected by rising temperatures and increased drought (IPCC, 2007). Agricultural resilience is therefore a key part of adaptation, especially in countries with large populations dependent upon subsistence farming (IAASTD, 2008; Herrero et al, 2010).

Protecting biodiversity and ecosystems – and using them sustainably in the case of culturally modified systems – is the best way to preserve and enhance their resilience and one of the most cost-effective defences against the adverse impacts of climate change. An ecosystem-based approach to adaptation is crucial to ensure ecosystem services under conditions of climate change.

Sources: builds on Chapters 8 and 9 of TEEB 2011.

Table 7.7 Summary of Identified Climate Change Impacts: ENPI East Countries

Climate Variable		Direct Impact (Sectoral/Cross-sectoral)	Armenia	Azerbaijan	Belarus	Georgia	Moldova	Russia	Ukraine
Temperature	Means	Ecosystems	X		X		X		X
		Energy			X				
Temperature	Variability	Health	X	X		X		X	X
Precipitation	Means	Water - resources	X	X		X	X	X	
		Water - desertification	X					X	
		Water – Agriculture	X		X	X			X
Precipitation	Variability	Forest fire						X	
		Infrastructure/Floods	X	X		X	X	X	
Sea Level Rise	Mean	Coasts		X		X		X	X

Table 7.8 Summary of Identified Benefits from Adaptation to Climate Change: ENPI East Countries

Benefit	Source of Benefit	Armenia	Azerbaijan	Belarus	Georgia	Moldova	Russia	Ukraine
Health	Heat wave - respiratory/cardio morbidity/mortality		X		X			X
Environmental	Coastal protection - wetlands		X					
	Forest protection	X					X	
	Biodiversity Plans implementation				X	X		X
Economic	Investment in flood protection	X	X			X	X	
	Coastal protection - salinisation							
	Investment in water storage & efficiency	X			X	X	X	
	Energy savings			X				
	Agricultural benefits - temperatures			X				X
	Tourism benefits - temperatures				X			X
Social	Coastal restoration - community		X					
	Arising from other categories (Ec.Soc.Env)	X			X			X

Box 7.5 Case Study: Water resources for agriculture in Armenia

The climate change assessment in Armenia identifies the fact that under the current projections to 2030, higher temperatures and reduced precipitation will result in an expansion of crop-producing areas that need irrigation, at the same time as increased evaporation from the soil resulting in the secondary salinisation of land. Furthermore, a greater frequency of heavy rainfall events is projected to further worsen water induced erosion, whilst droughts and hot dry winds will aggravate wind erosion. As a result, without adaptation measures soil humidity in Armenia will reduce by 10-30%, moisture availability for various crops will decline by 7-13%, and the water deficit of land will increase by 25-30%. As a result, the rain-fed farming in pre-mountainous and lower mountainous areas of Armenia will become more vulnerable. Therefore, by 2030 a decline of 8-14% in the yields of the main agriculture crops is forecasted (9-13% for cereals, 7-14% for vegetables, 8-10% for potato and 5-8% for fruits). A decrease of 4-10% is forecasted for the total pasture area and its yields, including 19-22% in the most valuable pastures of the sub-alpine and alpine zones. A 7-10% decrease in the yields of grasslands is possible, which, in its turn, will result in lower levels of fodder production.

A wide variety of adaptation measures are recognised to be available. These include:

- Reduction of losses in the irrigation and drinking-household water supply system through repairs of the systems and pipelines;
- Accumulation of moisture (water) in irrigated fields through storage of snow or snow melt water;
- Replenishment of moisture through early spring sowing of crops in rows, deepening irrigation ditches and using polyethylene covers;
- Use of advanced agro-technical measures and water-saving irrigation methods (drip-subsurface irrigation, pivot and sprinkler irrigation, subsurface drip-pipe and mole irrigation);
- Select and introduce more drought- and heat-resistant species and hybrids, including protect and spread traditional local species with those characteristics;
- Shift the farming zones to areas with more moisture

As a consequence of the implementation of these measures it is anticipated that the resulting increased availability of water due to decreasing water losses could be used to further secure the production and marketing of food. Further, employment opportunities in the agricultural sector would be maintained and, depending on the adaptation method, may be increased. Considering the impact of locally grown goods on food prices, the maintained yields of crops would enable lower, more socially desirable, pricing to prevail. Thus, the number of households vulnerable to food insecurity would be stabilised or reduced. It can then be expected that currently marginally secure households will benefit from reduced food insecurity and related effects such as malnutrition and social unrest.

Overall, a significant and accelerating trend in mean temperature has been identified in this region. An increase of 0.41^{0}C per decade was observed for the period 1979 to 2005. By the end of the current century it is estimated that an increase of up to 5.5^{0}C may occur. Over this century rainfall patterns are likely to change, resulting in dryer summers but more extreme rainfall events resulting in increased flood risks.

These trends in climate are projected to result in a wide variety of impacts across sectors in the region. In many cases, climate-related risks simply exacerbate environmental threats described in detail in other sections of this report. For example, most concern relates to an exacerbation of existing constraints on water resources arising from changing rainfall patterns combined with higher rates of evapotranspiration. Benefits of adapting to this risk through investment in effective storage and supply are recognised as being realised by domestic and industrial users as well as agricultural producers.

Infrastructure investment in sea defence is also judged to be a worthwhile investment, especially where valuable natural and human assets are at direct risk in the coastal areas of the region. For other risks such as heat-wave-related health impacts associated with respiratory and cardio-vascular conditions, benefits from reduced impacts may be better realised through a combination of education and awareness-raising activities as well as an investment in a heat alert system. Other important benefits from adapting to climate change in the region will result from flood management that reduces property damage and effective conservation management strategies that protect key ecosystem services.

Some of the measures will be man-made technological solutions, but there are also important opportunities for ecosystem based adaptation – working with natural capital to adapt. These can also have useful co-benefits though wider ecosystem service provision.

7.4 Conclusions – climate change related benefits

The ENPI region faces increasing pressures from climate change and a response to these pressures includes both contributions to climate mitigation and by strategies and measures to adapt to climate change. Increasing the contribution of renewable energy sources (RES) offers a significant opportunity to reduce greenhouse gas emissions and contribute to avoiding global warming while at the same time supporting objectives of energy security and creating further employment. Climate adaptation will be an inevitable necessity, indeed already a present necessity, and both man-made technological solutions and ecosystem based adaptation approaches merit attention in the region.

8 SUMMARY AND CONCLUSIONS

8.1 Key Messages

Key messages from the work on the benefits of improving the environment in ENPI East in the areas of air, water, waste, nature and climate change, include the following.

8.1.1 Key Messages: Air

1. Air quality is currently a significant environmental hazard across ENPI East, in particular in major cities with high populations and/or industrial complexes close by, resulting in sizeable negative impacts on public health, ecosystems, crops and materials. Air pollutants result principally from stationary sources – such as metallurgical industries, mining, and oil processing sectors – and from transport (use of poor quality fuels, aging fleet, increasing number of private cars).
2. Principal benefits resulting from reduced emission levels of a range of pollutants include: improvements in human health (pulmonary and cardiovascular illness); higher crop yields (nine crops including potatoes, barley and wheat); and reduced soiling of building materials. Air pollution impacts on ecosystems and cultural heritage would also be reduced as a result of lower emissions.
3. Total emission reductions of sulphur dioxide, nitrogen oxides, particulates, volatile organic compounds and ammonia by 50 per cent from projected 2020 levels in all the Eastern partner countries are presented in the table below.

Table 1 Air pollutant emission reductions in the Eastern partner countries (thousand tonnes)

NH3	NMVOC	NOx	PM2.5	PMco	PM10	SO2
840	5079	2518	674	413	1087	3932

4. As a result of these emission reductions over the period to 2020, the numbers of premature deaths and cases of chronic bronchitis that could be avoided annually rises up to between 30,000 – 90,000 and 50,000 – 160,000 respectively by 2020.
5. The total monetised benefits realised domestically as a result of each country's reductions could be as much as €200 billion (PPP) per year, (higher bound estimate)[45] of which 90 per cent would be made within Russia, as a result of the emission reductions in that country.

[45] This reflects the high end of the range of values estimated in Russia, which is €182bn – i.e. 90% of the high end €200bn total for ENPI East. Note that the results in the country reports only reflect the central range of values whilst the regional reports report the full ranges, reflecting the modelled uncertainties. Lower bound values for Russia and ENPI East in total are €56bn and €62bn respectively, whilst central values are €97bn and €107bn, respectively.

6. According to the indicative estimates made, a further €120 billion (PPP) of benefits could be realised per annum from 2020 if changes in impacts outside national borders as a result of domestic reductions were also considered (higher bound estimate). Benefits to human health are estimated to account for around 90 per cent of all the quantified benefits, due to reductions in the incidence of respiratory and cardio-pulmonary illnesses.
7. These results therefore suggest that future (or currently initiated) regulation should address both stationary and non-stationary sources and consider technological options as well as spatial planning.
8. Future research should focus on more detailed, context-specific modelling of the air quality impacts, as well as using this information to conduct cost-benefit analyses of alternative strategies to improve air quality.
9. Air quality strategies are likely to be more cost-efficient if they are designed to exploit synergies that exist with climate change policies that regulate greenhouse gas emissions. Such synergies should therefore be recognised in the design of national and regional environmental policies.

8.1.2 Key Messages: Water

10. Provision of a centralised drinking water supply varies across the Eastern partner countries. For urban populations, the highest levels of provision are found in Armenia and Belarus and the lowest in Azerbaijan and Moldova. For rural areas there is more variation between countries. In Armenia and Belarus over 70 per cent of rural populations have access to piped water supplies, but this is between 20 and 25 per cent in Azerbaijan and Ukraine.
11. The level of connection to the sewage network also varies. In some urban areas this can be relatively high. However, for rural populations the degree of connection to sewage networks is much lower and there are significant proportions of the rural populations without access to any form of improved sanitation.
12. Even in countries with relatively high coverage of population with piped water supply and a central sewage system, such as in Georgia, the water supply challenges can remain significant. Factors that impact negatively on the quality of drinking water and reliability of the overall water supply system include pollution (with untreated waste water) of surface water sources, worn out and badly maintained distribution systems (with leaks and regular breakdowns) and inappropriate water treatment. The quality of the drinking water is problematic in particular in larger cities which take their water largely from polluted surface water sources. While tap water is often of inadequate quality, the situation is even worse for the population which is not serviced through a centralized drinking water system, in particular in some rural areas, and which consumes water from wells. Such water is usually not treated and often contains a high number of chemical and biological contaminants. The situation is worsened by the fact that water quality monitoring is often limited, both in the number of controls and of parameters. As such, public health and welfare is not ensured in several regions, with regular outbreaks of water related diseases, such as hepatitis, shigellosis and diarrhea.

13. Meeting targets of full connection to drinking water and sewage collection would mean an additional 53.6 million people in ENPI East, would have reliable and safe piped water to premises, and an additional 85.8 million people would have connection to a sewage network system.

14. Overall, across the region, the benefits that would accrue from improved drinking water quality and sewage connection would be between 31 million and 66 million annual cases of diarrhoea avoided and between 832 and 1,674 deaths avoided.

15. The annual monetised benefits that would accrue from improved drinking water quality and sewage connection would be between €4.8 billion and €10.4 billion for morbidity (avoided illness), between €0.84 billion and €1.7 billion for mortality (avoided early mortality), which would give total annual benefits of between €5.6 and €12.1 billion. These benefits represent between 0.14 per cent and 1.08 per cent of the GDP of individual countries. All values are in € PPP.

16. Surface water quality varies, with many water courses suffering from pollution, often from old or inadequate infrastructure, as well as from also from direct discharge of untreated sewage, also industry, inefficient agricultural practices (large irrigation schemes resulting in salinisation, heavy reliance on fertilizers and pesticides), tourism/recreation (at lakes and beaches with insufficient facilities, such as toilets or bins) and waste dumpsites. Improving this would bring significant benefits for residents and users, such as fishermen, and for property values, etc.

17. The benefits of meeting water quality improvements vary between €30.7 and €229 PPP per household per year. If compared to GDP the benefits would be 0.11-1.73 per cent of the GDP of individual countries.

18. Water scarcity is also a problem is some parts of ENPI East. In Georgia and Ukraine, while overall water scarcity does not seem to be a problem at national level, it is an issue at local level, because of the unequal distribution of the resources throughout the country. As such, the inhabitants of the semiarid eastern regions of Georgia frequently suffer from severe water shortages, while the western regions are subject to flooding due to an overabundance of rainfall. Droughts cause significant economic damage. Better water management would bring additional economic, as well as social and environmental benefits.

8.1.3 Key Messages: Waste

19. Municipal waste collection coverage is an issue in most Eastern partner countries. None succeed in reaching full waste collection coverage, especially in rural areas. Better coverage would avoid wild tipping or unmanaged dumpsites, burying and burning of waste, and their related impacts on health and environment. Jobs can be created as well as more viable living conditions.

20. A shift from dumpsites to well managed sanitary landfills would have a considerable environmental impact. Sanitary landfills avoid nuisance, odour, fires and smoke (often with dioxin emissions), runoff water impact, soil water impact and health risks from scavenging.

21. Recycling avoids the remaining landfill impacts, generates jobs and makes material resources available for the industry. Sorting at source and adapted collection systems are the first conditions to reach high quality recycling. The present informal recycling sector can be professionalised and its activities can grow considerably. Only a minor fraction (mostly metal, paper, plastic, and glass) of the collected municipal solid waste is being recycled in most countries. Increasing recycling can reduce material imports which can help in overall resource efficiency. Increasing recycling can reduce material imports which can help in overall resource efficiency and positively affect the balance of trade.
22. Back-yard (home) composting and capital extensive (windrow) composting of source separated material are good solutions to divert biodegradable waste from landfills, and it creates a valuable material to fight soil degradation.
23. Biodegrading wastes cause the production of methane, a strong greenhouse gas, which escapes from landfills and dumpsites. Avoiding these emissions through enhancing collection coverage and diverting biodegradable waste from dumpsites and landfills is the first and major measure to take when addressing greenhouse mitigation measures in the field of waste policy
24. Complementary methane can be captured on well-equipped landfill sites. Captured landfill gas can be flared (oxidising methane to CO_2 and reducing its impact with a factor 25), or it can be used to generate electricity or to be distributed as natural gas.
25. Calculable and monetisable benefit assessments can be made of: surface of avoided dumpsites, amounts of supplementary collected municipal solid waste, amounts of supplementary composted or recycled waste, jobs created for collection and waste treatment, overall value of supplementary sound waste management, based on WTP, and marketable values of avoided CO_2 equivalent emissions. This first ENPI wide assessment (using ENPI wide common targets) gives the following order of magnitude estimates of the benefits:
    - Enhanced waste coverage will likely lead to significant avoidance of polluted land – preliminary estimates suggest that this could be in the order of a 100 to 300 thousand m^2 for from Armenia to Georgia and Azerbaijan to millions of m^2 in other countries - 1 million m^2 in Belarus, 3.5 million m^2 in Ukraine and around 10 million m^2 in Russia.
    - Increased waste treatment by expanding collection coverage and sanitary landfill capacity could avoid around 17.8 million tonnes of waste, lead to 15.6 million tonnes of additional waste recycled or composted and six and half thousand additional jobs generated in the region for landfill, recycling and composting.
    - Overall around 30 million more people could benefit from increased waste collection coverage under the target, leading to around €2.6 billion (PPP) benefits per year for the region.
    - There are considerable potential benefits from improved waste management also for climate mitigation. Over the region almost 4.9 billion m^3 of methane could be avoided per year, with a value of around €4.6 billion per year.

8.1.4 Key Messages: Nature

Biodiversity is of immense intrinsic value and human well being depends upon it. It is the 'natural capital' that provides a country, its economy and its people with a flow of goods and services that are fundamentally important for prosperity, livelihoods and well-being. The values we receive from our natural capital are immense, and failure to adequately take these values into account in our decisions exposes us to the risk of losing yet more of it.

Biodiversity in the region

26. The status of biodiversity is poorly known in much of the region, but it is clear that there is on-going degradation of most ecosystems, and many associated species are declining. Consequently a substantial number of species are threatened nationally, some of which are at risk of global extinction.
27. The main threats to biodiversity in the region include: logging natural / near-natural forest, and expansion of commercial forestry (especially in Russia), overgrazing and desertification, expansion of agricultural land and agricultural intensification, wetland drainage, pollution, illegal hunting and overexploitation of some species, especially fish, and the spread of invasive species.
28. One of the principal means of protecting biodiversity (and associated natural capital) is through the protection of areas of very high biodiversity that are at risk of degradation. This is recognised by the Convention on Biological Diversity (CBD), which has set a target of achieving at least 17 per cent of protected area coverage of terrestrial and inland water bodies, and 10 per cent of marine areas, by 2020. Although it is difficult to obtain consistent and up-to-date data on protected area coverage (due to differing national interpretations of protected area definitions, and on-going protected area expansion), it is clear that the achievement of the CBD target would substantially increase the protection of biodiversity within the region. Only Georgia has a protection target that exceeds the CBD target (20.2 by 2010). Most other countries would need to increase their current coverage considerably to reach it, and go beyond their intended targets. The greatest increase in protected area coverage would be for Russia, as its current protected area coverage is only 2.4 per cent. However, it is apparent that increases in protected area coverage would particularly benefit the biodiversity rich Caucasus region, the peatlands of Belarus and the wetlands and steppe lands of Ukraine.
29. It must be remembered that protected area coverage is a crude measure of biodiversity conservation effectiveness, as the strength of protection and appropriateness of land and marine management measures within protected areas is of key importance. In this respect it is clear that considerable improvements could be made in the designation of protected areas and in the effectiveness of protected area management in the region.
30. There is considerable uncertainty over the potential ecosystem service related benefits of increasing protected are coverage in the region. However, the assessments indicate that the most important benefits of increasing protected area coverage in the region are likely to be related to the protection of carbon reserves

(especially in the peatlands of Belarus), the improvement of raw water resources in terms of quality and quantity (through better protection and management of vegetation in vulnerable catchments), capturing of pollutants from waste water and run-off (e.g. from agricultural land) in catchments of water bodies that are polluted or vulnerable to further pollution and habitat provision for threatened species. Some significant benefits could arise with regard to cultural services, but it is uncertain to what extent protected areas are needed to maintain such services in the region.

Forests, unsustainable forest management and carbon storage

31. Forest cover in the Eastern partner countries as a whole is at almost 48 per cent of territory; the highest level is in Russia, both in terms of percentage coverage (nearly 50 per cent) and particularly in area coverage (809 million hectares). Coverage in Belarus and Georgia is also very high with both around 40 per cent coverage.

32. Deforestation is currently an issue (at a net national level) only in Armenia and Georgia – though at a regional and local level there are challenges in most counties. Illegal logging and expansion of commercial forestry are threatening forests. A loss of a hectare of old growth forests generally implies a far greater loss of ecosystem services (carbon stored, water retention and storage) and biodiversity than afforestation achieves.

33. Forests mostly have multiple ecosystem services and generally designated and managed for a more restricted set of uses. Many forests have been designated specifically for production (particularly in Russia, Belarus and Ukraine), others for the protection of soil and water (particularly in Azerbaijan and Georgia, and also Armenia). A range of forests are also designated for the conservation of biodiversity (e.g. as protected areas) – up to 14 per cent in Belarus. Some are designated as multifunctional forests.

34. Carbon storage: forests in the Eastern partner countries contain just over 34 billion metric tons of carbon in living forest biomass, equivalent to almost 125 billion tonnes of CO_2. This is, however, an underestimate of the carbon storage in forests given that there are also important quantities in the soil and litter.

35. Meeting the ENPI wide target of halting net deforestation by 2020 will (at a net level) only be a relevant target for Armenia and Georgia (halting all deforestation would affect all countries as there is land use change in all) – with the potential to avoid the emissions of about 4.4 million tonnes of CO_2 from lost living forest biomass. This is small compared to the total carbon store, but nevertheless significant.

36. Value of carbon storage, avoided loss and stock gains: Assuming a value of CO_2 of 17.2 €/ton (low) and 32 €/ton (high) in 2010, the value of the carbon currently stored by the forests in the Eastern partner countries could be estimated to range between €2,000 to 4,000 billion (see later point on stock and marginal values). This is an indication of the value of the carbon stored in the living biomass today.

37. By 2020, the stock of carbon in living biomass - assuming projected carbon values of 39€/ton (low) and 56€/ton (high) – would suggest values of between nearly €5,000 and 7,000 thousand billion. In Georgia and Armenia, under the halting forest loss by 2020 target, between €170 and 250 million of potential carbon losses could be avoided.

38. To underline the benefits of forests as carbon store, an estimate has been made of the projection in carbon value from the continued growth of forests – this has been estimated to lead to a carbon gain of €6,000 to 8,600 million for the Eastern partner countries.

39. Countries considering own analysis would naturally wish to explore the net/gross loss issue in considerably more detail – ideally covering all aspects of carbon (living/dead; above and below ground; soil/vegetation) as well as key ecosystem services. There is a new momentum as regards appreciating the wider benefits of natural capital and new evidence in the partner countries would offer important added value to the global literature/evidence base and hence governance of natural capital.

Land degradation

40. Agricultural production across ENPI East accounts for between 6 and 18 per cent of GDP, with an overage of 10 per cent. It is, therefore an important contributor to the economy.

41. However, much agricultural land suffers from degradation. Depending on the country, anything from 6 per cent to 100 per cent of the agricultural land is severely or very severely degraded. To cite an example, in Georgia nearly 35 per cent of agricultural land is degraded to some degree by water or wind erosion, which is, with desertification of land, the main identified type of human induced land degradation. Other types of soil degradation include loss of organic matter and biological activity, physical degradation, water logging, salinization and alkalization, acidification and loss of chemical fertility. The degradation is caused by climatic conditions, and largely by unsustainable agricultural practices (cultivation of steep slopes, land-reclamation schemes, chemical deterioration of the soil, due to uncontrolled use of pesticides and fertilizers standards, overgrazing). The land degradation heavily affects local households, leading to decreased land fertility, lesser yields, lower quality crops and, finally, increases poverty.

42. Better crop management systems and more sustainable agricultural practices (avoiding overgrazing, erosion and inefficient irrigation - leading to salinization) would tackle much land degradation, reducing the loss of soils, reducing soil salinity and replenishing nutrients and maintaining soil structure.

43. If these poor management problems are address, crop yields would increase from between 2.9 to 16.8 per cent across the region.

44. The benefits of improved crop production include health, environmental and on- and off-farm social and economic benefits. The estimated total benefit is € 8.1 – 14.6 billion (PPP) in 2020. This represents 0.1-0.15 per cent of GDP in Georgia and Russia and 1.5-2.0 per cent of GDP in Ukraine and Moldova.

8.1.5 Key Messages: Climate change

Renewable Energy Sources (RES)

45. Energy consumption causes around 2.0 billion tonnes of CO_2 emissions per year in the region, i.e. an average of 9 tonnes CO_2 per capita per year (the population of the region was 218 million in 2008). There is a wide range across the countries in the region, with per capital emission from energy going from 1.1 (Georgia) tonnes of CO_2/capita/year to 11.2 (Russia) tonnes of CO_2/capita/year, reflecting climate, energy resources and infrastructure, economic activity, and social norms.
46. Renewable energy sources (RES) contribute around 3 per cent of gross final energy consumption in ENPI East (in 2008). They provide 21.2 mtoe of a total of 549 mtoe final energy consumption for the region. The RES share ranges from 1.6 per cent (Ukraine and Azerbaijan) up to 36 per cent in Georgia.
47. Potential for renewable energies: The increased uptake of renewable energy sources represents a major potential for the region to reduce GHG emissions, offers health benefits (as the reduction of air pollution from fossil fuels combustion would improve air quality, reduce exposure to pollutants and hence reduce respiratory diseases) as well as addresses energy security, dependency on imported (Russian) energy (e.g. Georgia) and cost issues. RES also has a potential to create new employment and be a driver of the economy. Also, renewable energy systems can support decentralized markets and as such encourage local economic development (Ukraine, Georgia). If a renewable energy project is being registered as a Clean Development Mechanism project, extra revenues through the sale of emission credits can accrue. RES, however, also have environmental impacts, most notably large hydro plant.
48. In ENPI East the amount of gross final energy consumption from RES, were a 20 per cent renewable energy target met in 2020, can be estimated at 115 mtoe – using a conservative energy conservation baseline(energy per capita remaining constant, with increases in use (transport, production, energy using products) taken to be compensated for by efficiency gains).
49. An increase of the RES share of gross energy consumption from current levels to 20 per cent is estimated to reduce CO_2 emissions by about 346 million tonnes CO_2 by 2020.
50. Assuming a CO_2 value ranging from €39 and €56 per tonne in 2020, the reduced emissions of CO_2 estimated above will represent a saving of between €13 and €19 billion per year in 2020. For the purpose of comparing the results to current money values, if the RES target were to be met today, the benefits from reduced emissions would be between €6 and €11 billion year given lower carbon prices (€17 and €32 per tonne in 2010).

Climate impacts and adaptation

51. A significant and accelerating trend in mean temperatures has been identified in this region. An increase of 0.41^{0}C per decade was observed for the period 1979 to 2005. By the end of the current century it is estimated that an increase of up to 5.5^{0}C may occur. Over this century rainfall patterns are likely to change, resulting in dryer summers but more extreme rainfall events resulting in increased flood risks.
52. These trends in climate are projected to result in a wide variety of impacts across sectors in the region. Whilst agricultural crops may benefit from enhanced CO_2 fertilisation effects, over time these benefits are thought likely to be outweighed by water constraints and flooding that both reduce crop productivity.
53. The most common impacts identified across the region are i) constraints on water resources arising from changing rainfall patterns combined with higher rates of evapotranspiration; ii) heat wave-related health impacts associated with respiratory and cardio-vascular conditions, and iii) the impacts on infrastructure and other resources as a result of river flooding.
54. The potential impacts of climate change on ecosystems and biodiversity, agriculture and coasts are also recognised as being significant.
55. The recognition that climate change is occurring and is likely to continue has led to a wide variety of adaptation measures being considered to combat this range of potential climate change impacts. Emphasis is being put on adapting to projected water resource constraints in order to provide security of supply to domestic and industrial users as well as agricultural producers.
56. Both man-made technological solutions and ecosystem based adaptation approaches (working with nature to adapt to climate change) should be explored on an equal footing and in light of wider benefits.

8.2 Recommendations

The insights from the analysis in the country studies underline that the environment merits being given greater attention in policy making, implementation, financing and enforcement. This offers benefits in terms of cost savings, potential contributions to a range of important non-environmental policy objectives, improved security (food, water, energy, climate) and improved quality of life of citizens.

Strengthening national environmental policies/targets and obtaining due support for their implementation, should result in progress in each of the air, water, waste, nature and climate change domains. Such progress will be a valuable step in the transition to a green, equitable economy. Environmental technologies can be a core driver of green, equitable growth and of job creation. Improving infrastructures is an opportunity to benefit many millions across the region in access to quality services, for example the areas of water or waste management. Safeguarding productivity by avoiding the degradation of natural capital also has the potential to help improving the standard of living.

The assessments done under this project, should be seen as a first illustrative estimate and not as a final definitive analysis. For national policy reflections, own analysis could usefully be carried out to complement the indicative calculated under this project. Having a core set of country specific assumptions with a range of scenarios and sensitivities would offer additional nuance and robustness. National/local policymakers and stakeholders could therefore adapt the analysis framework used for the country benefit assessments and tailor the methodologies that have been developed and applied under this project.

All methodologies and assumptions are fully documented in the Benefit Assessment Manual (BAM), which has been developed under this project. Like the other project results, this Manual is planned to be published on the project website and to become available, upon request, from the European Commission's EuropeAid, DEVCO F3, Regional Programmes Neighbourhood East.

This should facilitate countries wishing to complement the assessment in this report with additional and/or more tailored assumptions. The results of this project could thus be taken further by the countries and used for conducting their own national benefit assessment studies, in order to support good governance and facilitate identification of priority areas for progress. A culture of benefit assessments and taking account of the wider picture of benefits in decision making should be encouraged.

Investment in measurement and data is key for management. There is a need for good data, indicators, and also a move towards (environmental) capital accounts and satellite accounts to help ensure that policy makers have due information at their disposal.

Finally, it should be kept in mind that the faster environmental policies are implemented, the earlier the benefits will be obtained and the longer these will be enjoyed. Acting quickly will also help avoid costs (of inaction) that can be significantly more costly than late action, so there is a double benefit of early action.

There is a major potential for ENPI East countries focusing on a range of environmental improvements to help in the transition to a green economy. This will benefit not just the environment (water and air quality, conservation status, forest health and soil quality), but also benefit health and wellbeing, livelihoods (jobs and community viability), economics and financing (avoiding costs) as well as supporting good governance. Focusing on the environment should prove a key thread to sustainability in times of austerity.

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