Analysis for European Neighbourhood Policy (ENP) Countries and the Russian Federation on social and economic benefits of enhanced environmental protection

Lebanon
COUNTRY REPORT

Fadi Doumani and Hanadi Musharrafiyeh
(Independent experts)

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Contributing authors:

- Larsen, B.: Chapters 4.2 Benefits from improved connection to safe drinking water, improving the connection to the sewage network and hygiene conditions and 6.4 Benefits from reducing cropland degradation
- Lago, M.: Chapter 4.5 Benefits from improving surface water quality
- Hunt, A.: Chapters 3.2 Benefits from improved ambient air quality
- Spurgeon, J.: Chapter 4.6 Benefits from reducing water resource scarcity
- Ten Brink, P.: Chapter 6.3 Benefits from forests and reducing deforestation
- Van Acoleyen, M.: Chapters 5.2 Benefits from improving waste collection coverage, 5.3 Benefits from improving waste treatment and 5.4 Benefits from reducing methane emissions from waste.

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Exchange rate used:
€ 1 = Lebanese pound (LP) 2,206.0 (2008 and 2020);
€ PPP 1 = Lebanese pound (LP) 1,294.2 (2008 and 2020);
€ PPP 1 = € 1 (2008 and 2020) in the Euro Zone for the Carbon Market; and
US$ 1 = Lebanese pound (LP) 1,507.5 (2008).
Source: World Bank (2010); and <www.oanda.com>

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The benefits in this report have been assessed, using available data, the source of which may not be entirely reliable, and with considerable data gaps requiring several assumptions. The results are therefore considered indicative only, providing an order of magnitude. However, the results are considered useful for making benefits of enhanced environmental protection understandable to a wide audience.

The contents of this publication are the sole responsibility of the authors and can in no way be taken to reflect the views of the European Union or the Government of Lebanon

ACRONYMS

ALMEE..... Lebanese Association for Energy Saving and for Environment
AFRI..... Acute febrile respiratory illness
AQ.....Air Quality Directives
BA ..... Benefit Assessment
BAU..... Business as usual
BB..... Baalbeck and Beqaa
BFT..... Benefit Function Transfer
BML.....Beirut and Mount Lebanon
CAS..... Central Administration for Statistics
CBD ..... Convention on Biological Diversity
CEDRO..... Community Energy Efficiency & Renewable Energy Demonstration Project for the Recovery of Lebanon
CH_4..... Methane
CO_2..... Carbon Dioxide
COED..... Cost of Environmental Degradation
C&D..... Construction and demolition
CV ..... Contingent valuation
PCCV ..... Payment card contingent valuation
DALYs..... Disability Adjusted Life Years
DCCV..... Dichotomous choice contingent valuation
EC..... European Commission
E. coli ..... Escherichia Coli
EDL..... Electricité du Liban
EE ..... Energy efficiency
EEZ..... Exclusive Economic Zone under UNCLOS
ENP ..... European Neighbourhood Policy
ENPI ..... European Neighbourhood and Partnership Instrument
EPA..... Environmental Protection Agency of the United States
EU ..... European Union
FAO ..... Food and Agriculture Organisation
GAC..... Government-appointed committees
GEF..... Global Environment Facility
GES..... Good Ecological Status
GDP..... Gross Domestic Product
GI ..... Gastrointestinal
GIS..... Geographical Information System
GIZ ..... Gesellschaft für Internationale Zusammenarbeit (previously GTZ)
GLASOD ..... Global Assessment of Soil Degradation
Ha ..... Hectare
IBAs..... Important Bird Areas
IEEP..... Institute for European Environmental Policy
Kg..... Kilogram
Km..... Kilometre
Km^2 ..... Square Kilometre
kTOE..... Kiloton of oil equivalent

LP ..... Lebanese pound
LCEC ..... Lebanese Centre for Energy Conservation
m ..... Meter
m^2 ..... Square meter
m^3 ..... Cubic meter
MOA ..... Ministry of Agriculture
MOE ..... Ministry of Environment
MOEW ..... Ministry of Energy and Water
MOF ..... Ministry of Finance
MOPH ..... Ministry of Public Health
MSA ..... Mean Species Abundance
MSW ..... Municipal Solid Waste
NBSAP ..... National Biodiversity Strategy and Action Plan
NEEREA ..... National Energy Efficiency and Renewable Energy Action
NL ..... North Lebanon
NMVOCs ..... Non-Methane Volatile Organic Compounds
NOx ..... Nitrogen Oxides
NPMPLT ..... National Physical Master Plan of the Lebanese Territories
O&M ..... Operations and Maintenance
PM ..... Particulate Matter
PPP ..... Purchasing Power Parity
RES ..... Renewable Energy Sources
RWE ..... Regional Water Establishment
SL ..... South Lebanon
SOx ..... Sulphur Oxides
SO_2 ..... Sulphur Dioxide
TARWR ..... Total Actual Renewable Water Resources
TEEB ..... The Economics of Ecosystems and Biodiversity
TEV ..... Total economic value
TOE ..... Ton of oil equivalent
UNCLOS ..... United Nations Convention on the Law of the Sea
UNFCCC ..... United Nations Framework Convention on Climate Change
UNDP ..... United Nations Development Programme
UNEP ..... United Nations Environment Programme
USAID ..... United States Agency for International Development
VOCs ..... Volatile Organic Compounds
VSL ..... Value of Statistical Life
WEI ..... Water Exploitation Index
WFD ..... EC Water Framework Directive
WHO ..... World Health Organisation
WTP ..... Willingness to Pay
WWTP ..... Waste water treatment plant

EXECUTIVE SUMMARY – ENGLISH / ARABIC

The European Union, represented by the European Commission has contracted a consortium led by ARCADIS Belgium N.V. to undertake an analysis of social and economic benefits of enhanced environmental protection in the 16 countries covered by the European Neighbourhood Policy (ENP) and in the Russian Federation.[1] The other consortium partners are: Institute for European Environmental Policy (IEEP), Ecologic Institute, Environmental Resources Management Ltd., Metroeconomica Ltd., and several independent experts.

This is the executive summary of the benefit assessment report for Lebanon that has been prepared by a team consisting of an EU expert and a national expert, using a Benefit Assessment Manual developed under the project. This Benefit Assessment Manual, which was originally for internal use only, has been turned into a Benefit Assessment Manual for Policy Makers for wider dissemination. The Manual provides an understanding of the methodologies applied for the benefit assessment.

All project results, including the country benefit assessment reports, regional synthesis reports and the Benefit Assessment Manual, are available from the project website <www.environment-benefits.eu>.

Key environmental challenges

Lebanon is facing increasing pressures on its human, social, economic, natural and cultural assets driven by coastal urban demographic concentration and a construction boom that are affecting the quality of growth, life and the commons. Despite considerable progress in shaping its legal, regulatory and institutional framework and providing substantial public funds for financing its infrastructure after the Civil War, Lebanon is still at the early stage of its transition to sustainable development: the Ministry of Environment is facing difficulties in asserting its respective authority and executing its obligations (monitoring of certain indicators of public utilities services, environmental impact assessment, protected area committees, research, etc.). In addition, other entities such as the Tripoli Environment and Development Observatory, non-governmental organisations as well as academia with responsibilities for the environment face difficulties as their environment-related services are uncoordinated and sometimes ineffective. Hence, Lebanon is not always reaping the expected health, environment, economic and social benefits and faces several challenges in all its environmental sectors: air, water, waste and nature. These issues are mostly a result of human activities and are exacerbated by climate change effects.

Air pollution is worsening in major cities and industrial zones, especially in Greater Beirut due to the heavy traffic. In the absence of air monitoring systems (except in Tripoli), the lack of a modal transportation strategy, individual or communal power generators to compensate for power outage and a staggering inhabitant per car ratio (1.4 or 3 million cars for a population of 4.2 million with a large concentration in urban areas), the urban

1 EuropeAid DCI-ENV/2009/225-962 (EC).

population is increasingly subject to cardiopulmonary premature mortality and illness; as a result, these diseases are burdening the health sector services.

Water resources are mismanaged and surface water quality is mainly contaminated with organic matter with very little domestic and industrial waste water discharge being treated (19.1% and only 6% of generated biological oxygen demand is being removed from domestic discharge) whilst the water balance (1,090 m^3 per inhabitant in 2009) is projected to be positive at least until 2020. There is a disconnect between sovereign water and water use in Lebanon as most water outflows are not mobilised (only 11.1% of outflows) due to inequitable water sharing direct or indirect agreements with riparian countries. Water services are also mismanaged despite important investments since the early 1990s to improve water coverage and waste water treatment while irrigation remains the major ineffective water user. Poor services are leading to increased water-borne diseases whereas alternative water sources are sought by most inhabitants to palliate for poor water quality, quantity and regularity, and have to pay on average three times the water tariff rate.

Waste collection is close to 99% whereas treatment and disposal remain a major problem in terms of effectiveness and efficiency as 32% is often burnt after being dumped on land, in rivers or near the shore; and the 68% that is landfilled has the highest tonnage cost in the region with no incentive scheme for treatment. Furthermore, **methane emissions** from waste are neither systematically burnt nor captured, contributing to the increasing amount of domestic greenhouse gases emissions.

Nature. In terms of **biodiversity**, terrestrial and marine protected areas represent 0.4% of total surface area. Six out 10 nature reserves are managed by government appointed committees although fiscal transfers are irregular and cannot ensure a sustainable management of nature reserves. A traditional participatory approach, the *hima* system, is sought by NGOs in a number of protected areas with promising results. **Deforestation** is increasing due to poor land use planning, zoning and forest fires but is compensated by an increased afforestation effort while forests remain fragmented and represent 13% of the national surface area. **Rangeland** is increasingly fragmented by the construction boom especially along the Mount Lebanon slopes.

Climate change impacts are related to regional, spatial and temporal temperature increase, precipitation decrease and runoff decrease. Also, sea level rise, increased risk of forest fire, change in bio-indicators, increased event intensity and frequency, etc. are expected. These interlinked factors should be viewed in terms of a natural disaster-climate change continuum that will affect notably settlements, biodiversity, crop productivity, coastal zones, the acceleration of the rate of desertification and human health burden as the re-emergence of diseases and migration are also possible (vector-borne diseases, psychosocial stress, etc.). With regard to energy sources, currently only 4.2% of the total energy production relies on **renewable sources**. However, significant potential could be represented by solar, wind and hydro power.

Main benefits from environmental improvements

There are considerable benefits from taking immediate action to address the environmental problems facing Lebanon. These include improvements to health and reductions in mortality, economic savings and the potential for new economic opportunities, and widespread gains in community well-being. This report provides a first look at the potential social and economic value stemming from these improvements across environmental sectors. The numbers cited in this report are indicative only, based on a rapid assessment often using limited data and many assumptions. Awaiting more detailed assessments, it is expected that this report can already help to support policy-making and sound decision-making on environmental issues.

The valuations underscore a number of benefits that could accrue to society in 2020 should optimal investments be carried out. For each environmental issue, a 2008 baseline is projected to 2020 as a business as usual scenario that is compared to a 2020 target compliance scenario to derive specific qualitative, quantitative and possibly monetary[2] Benefit Assessments.

However, not all environmental benefits were able to be valued as data gaps exist and should be addressed by the authorities and development partners alike to improve decision making tools and reduce the uncertainties in particular for monitoring of: air pollution, surface and groundwater quality, waste water discharge, groundwater, land degradation, solid waste disposal, climate change impacts on fauna and flora, etc. More specifically, the benefits of addressing water scarcity, which will become a pressing issue in Lebanon after 2020, was not captured in monetary terms and needs particular attention.

Air pollution is an important issue in large cities and will require a rethinking of the modal transportation sector and a portion of the air pollution could be reduced (communal and individual generators are switched on during power outages) with the improvement of the power utility services. Benefits accruing to society in 2020 would be 376 avoided premature death cases and 564 avoided cardio-pulmonary cases in addition to improved crop yield and less decaying of infrastructure and buildings in 2020.

Air	Qualitative benefits	Quantitative benefits
	Cardio-pulmonary disease avoided Ecosystems and climate change Green opportunities and health spending reduced Quality of life: altruistic and environmental benefits	Avoided premature death cases: 376; avoided cardio-pulmonary cases: 564 Building decaying avoided; crop yield will increase Other benefits that were not quantified such as tourism gained due to cleaner air, green growth and jobs, etc.

Water provision, services, quality and scarcity constitute by far the most important issues as scarcity was not monetised in the Benefit Assessment although the problem will be exacerbated by demographic growth, economic activity (tourism) and especially climate change affects in the future. Benefits accruing to society in 2020 would particularly arise with full water and sanitation improved coverage: 16 avoided deaths from diarrhoea; 1.2

2 Monetary values are adjusted for Purchasing Power Parity (PPP), except for the carbon prices used as regards climate change mitigation, which are in €. Monetary values calculated using national values (e.g., health benefits associated with avoided impacts of air pollution, or other preferences) are thus in € PPP.

million avoided diarrhoea cases; 32,000 avoided gastro-intestinal and acute respiratory cases from swimming; 3.7 million people would be connected to liquid waste treatment; increased water consumer surplus to 4.6 million people due to improved services; and 17 rivers brought back to Good Ecological Status in 2020.

Water	Qualitative benefits	Quantitative benefits
	Water-borne disease avoided Watershed ecosystem; fisheries Country allocative efficiencies and household spending reduced Water provision convenient especially for the poor Business opportunities Quality of life: altruistic and environmental benefits; rebuilding the trust between inhabitants and water utilities	Avoided deaths: 16; avoided diarrhoea cases: 1.2 million; reliable safe piped water and improved hygiene for 4.7 million and 1.6 million connected to sewer; 32,000 gastro-intestinal and acute respiratory illness avoided from swimming; 3.7 million additional people will be connected to at least secondary treatment; improved service provision; 17 river water quality brought back to GES; other benefits were not quantified such as water scarcity, etc.

Waste disposal remains an issue especially along the coast and waste-to-energy facilities are sought that would avoid nimbysm and the provision of costly landfills in coastal areas. Nevertheless, the Benefit Assessment did not consider waste-to-energy as an alternative waste management option. Benefits accruing to society in 2020 of improved waste management in 2020 would be: 100% collection coverage; 62% landfilled in controlled landfills; 12% recycled waste; 12% composted waste; 82 million m^3 of methane emission avoided; 55.4 million m^3 available methane as an energy source; and 91 jobs created.

Waste	Qualitative benefits	Quantitative benefits
	Stress from sight and odour pollution avoided and minor health benefits (vector-borne disease) Land and water ecosystem quality, climate change Job creation, recycling business, carbon funding Quality of life: altruistic and environmental benefits; rebuilding the trust between inhabitants and waste services	100% collection coverage; 62% landfilled in controlled landfills; 12% recycled waste; 12% composted waste; 82 million m^3 of methane emission avoided; 55.4 million m^3 available methane as energy source; and 91 jobs created; other benefits that were not quantified such as the opportunity cost of land if waste-to-energy is envisaged; etc.

Nature. Except for forests, land degradation is on the increase with no political commitment to stop the degradation of the quality of the commons mostly driven by a poorly regulated construction boom. Benefits accruing to society in 2020 of addressing this problem would be: 100,000 tons of additional CO_2 stored; and 5% increase in crop yield.

Nature	Qualitative benefits	Quantitative benefits
	Psychophysical state improvement Land degradation avoided, improved total economic value of land and climate change Nomad benefit; yield improvement Quality of life: altruistic and environmental benefits	Carbon stock: 100,000 tons of additional CO_2 stored; crop yield increased by 5%; numerous other benefits were not quantified such as distinct landscape option values, etc.

Climate change issues have just started to get the attention of decision makers as forest fires should be the priority issue to be tackled. In terms of climate change, an implementation of the new energy plan with a gas, oil and renewable energy source mix will substantially reduce carbon emissions as the benefits were calculated and range between € PPP 504 and 560 million in terms of carbon avoided by 2020 (figures are not included in Figure 1 though) as the switch to renewable energy sources will only represent about one quarter of these

gains. Adaptation benefits accruing to society in 2020 would be in particular: 20% renewable energy equates to 2,731 kTOE CO_2 avoided whereas the new energy plan with the oil, gas and renewable energy mix equates to at least 13,000 kTOE CO_2 avoided; 45,080 m^2 coastal erosion avoided due to coastal erosion management with soft to hard defensive interventions; and 103 million m^2 of forest coverage saved from fire due to improved preparedness.

Climate	Qualitative benefits	Quantitative benefits
	Cardiopulmonary cases avoided TEV of land, water and marine environments is improved, coastal erosion avoided, climate change benefits Private sector opportunities Quality of life: altruistic and environmental benefits and energy coverage in remote areas	20% RES equates to 2,731 kTOE CO_2 avoided; the new energy plan with the oil, gas and RES mix equates to at least 13,000 kTOE CO_2 avoided; 45,080 m^2 coastal erosion avoided; 103 million m^2 of forest coverage saved from fire; numerous other benefits were not quantified such as risk of desertification, etc.

The monetary benefits analysed in this are far from all the benefits that could accrue to society from improved environmental policies. Of the analyses that were undertaken, the preliminary local and global benefits amount to € PPP 2 billion or LP 2.6 trillion equivalent to 4.2% of 2020 GDP (Table 1, Figure 1 and Figure 2).

Table 1 Global and local monetary benefit assessment - Lebanon, 2020 in € PPP million

Theme	Local		Global		Total	
	€ PPP million	% of 2020 GDP	€ million	% of 2020 GDP	€ PPP million	% of 2020 GDP
Air	456	1.0%	547	1.2%	1,003	2.1%
Water	570	1.2%			570	1.2%
Waste	44	0.1%	66	0.14%	106	0.2%
Nature	118	0.2%	7	0.01%	125	0.3%
Climate	68	0.1%	130	0.3%	198	0.4%
Total	**1,256**	**2.6%**	**750**	**1.6%**	**2,006**	**4.2%**

Note: at the global level, the € PPP 1 is assumed to be equal to € 1 in the Euro Zone for the Carbon Market.

The preliminary local benefits amount to € PPP 1.26 billion or LP 1.6 trillion equivalent to 2.6% of 2020 GDP with the following relative shares for the total benefits that were calculated: air (36.3% of total), water (45.4%), waste (3.5%), nature (9.4%) and climate (5.4%). Regarding global issues, the preliminary global benefits amount to € 0.75 billion with the following relative shares: air (72.9% of total; emission release avoided), water (0%), waste (8.8%; methane avoided), nature (0.9%; deforestation avoided) and climate (17.3%; additional renewable energy source mix).

Figure 1 Global and local monetary benefit assessment - Lebanon, 2020 in € PPP million

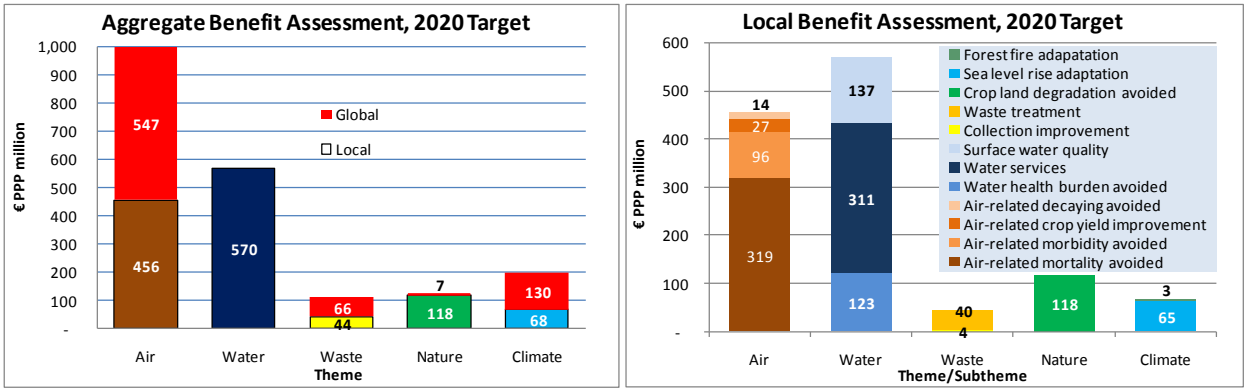
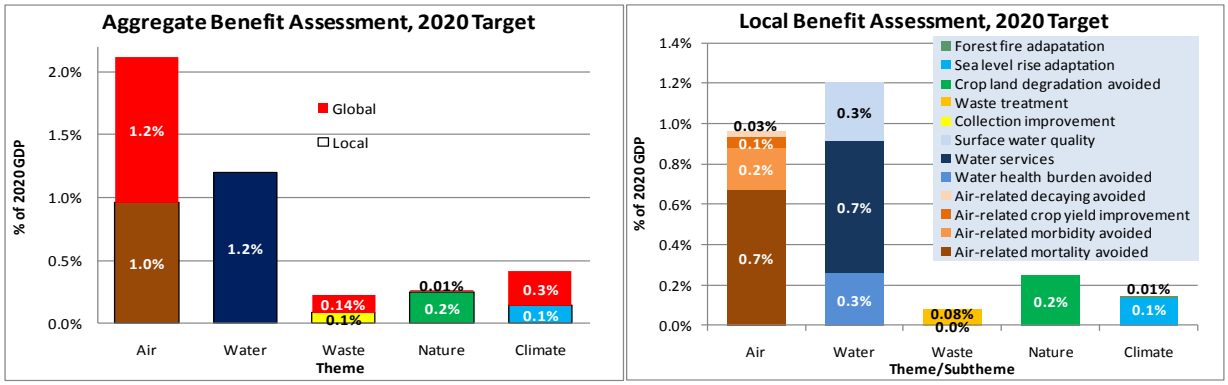


Figure 2 Global and local percentage benefit assessment relative to 2020 GDP – Lebanon



Recommendations

The present Benefit Assessment methodological process is a preliminary effort towards helping ENP countries mainstream, refine, improve and regularly update this tool, which should support the decision-making process with regard to local and global sustainable developmental issues. More significantly, there is now an important opportunity to determine the most effective, efficient and equitable cost alternatives (optimal investments) to select and implement key interventions to reach the targets set by the Benefit Assessment across the different environmental sectors. Indeed, these would not only reap significant local health, environmental, economic and social gains, but also be considered adaptive and mitigative responses to the future effects of climate change.

The Benefit Assessment results could be updated on a yearly basis by the Ministry of Environment in conjunction with the Central Administration for Statistics using the methodology developed by the Benefit Assessment programme. Therefore, the Benefit Assessment could be readily available every year to sector decision makers to factor in environmental benefits into their short to long priority programmes.

Data gaps were encountered across the environmental themes and there is a need to build one integrated environmental data system across line ministries and agencies that could be considered as an entry point for the mainstreaming of environmental benefits across sectors. The indicators developed in the Benefit Assessment checklist could be considered as

a base whose indicators would be gradually considered and collected across line ministries and agencies under the aegis of the Central Administration for Statistics in conjunction of the Ministry of Environment and possibly the Ministry of Finance. A needs assessment is warranted to take stock of the current set up that was already improved with the help of the EuroStat programme, determine the gaps in the indicators (hardware and software), assign indicator-gathering responsibility across sectors, and set up an environmental statistical system with management responsibilities and dissemination outlets. Moreover, this environmental data system could be integrated into a broader statistical collection framework that could feed into a multi-layered GIS that will provide decision makers with a better natural resource protection, prevention and management decision support system.

The Government of Lebanon has recently formulated a number of strategies, policies, master plans or guiding principles that the Benefit Assessment exercise could be built upon: Ministry of Energy and Water's Energy (adopted in 2011), Ministry of Energy and Water's Water, Waste Water and Irrigation (draft 2011), Ministry of Environment's Solid Waste (ratified in 2010), Ministry of Environment-UNDP's Closure and Rehabilitation of Uncontrolled Dumps (draft 2011), Council for Development and Reconstruction's Land Use Planning (ratified in 2009), the Ministry of Environment-GEF-UNDP's Fourth National Report to the Convention on Biological Diversity (2009), the Ministry of Environment-World Bank's Country Environmental Analysis (2011), the Ministry of Environment-UNDP's State of the Environment report (2011) and the Ministry of Environment-GEF-UNDP's Second National Communication to the United Nations Framework Convention on Climate Change (2011). There is therefore an opportunity to move the Benefit Assessment analysis forward by calculating all the benefits accruing from the options formulated in the various strategies, master plans and guiding principles that will help the government set priorities and make the most effective, efficient and equitable policy choices to promote green and sustainable growth.

Dealing with climate change affects is an imperative global survival issue but could easily disrupt important local developmental issues and policy choices. Indeed, the European carbon market is an important clearing house for the price of carbon that could give first hand signals to European investors interested in local environmental investments that reap marginal carbon benefits. Nevertheless, the global benefits of investing in carbon could distort the local benefits of investing in environment-related issues (e.g., water) with minor (sludge management) or no carbon value added. Hence, the balance between global and local environmental priorities should be re-equilibrated by ENP governments together with development partners to prevent a one-sided developmental track that could especially harm the poor.

The Way Forward

Overall, future benefit studies could focus on those areas where immediate investment is needed, in order to assess which solutions will have the highest benefits. These studies should take into account the regional character of some of the pressing environmental problems. For example, air pollution is of particular concern in urban areas; water resources management and water reliability are a pressing issue all over the country; and solid waste management. Such studies should be conducted in collaboration with local experts, which would also allow social and development issues to be taken more closely into account (e.g.

the implications of the use of fees and other market-based instruments, the link between poverty and environmental degradation).

The direct benefits for the local population (e.g., income and job generation for the poor, creation of small and medium enterprises), and the link between environmental improvements and sustainable development should be further stressed. Other economic benefits, such as the stress of green growth and market creation should also be further emphasised.

Other parameters and/or sub-topics could be included in future assessments, such as: water reuse, ground water pollution and transboundary issues (as part of 'surface water quality'); reduction of the use of fossil resources, energy efficiency and transport-related GHG emissions (as part of 'climate change mitigation'). Other parameters will benefit from the inclusion of additional indicators, once data become available, such as the inclusion of $PM_{2.5,}$ ammonia (NH_3) especially for Selaata and hydrocarbons (HC) in the "air quality" parameters. The range of impacts and benefits analysed could also be widened, for example by including a more detailed analysis on the quarries or the effect of climate change on the frequency and intensity of droughts, agriculture productivity, migration and food availability (under the "adaptation" parameter).

Future studies could also investigate feasible measures to meet the targets, either international or actual national targets. Further analysis will be needed on institutional capacity and on technological, infrastructural, legal and policy options. This could be complemented by capacity building and training workshops to stimulate prioritisation and actual implementation of the measures identified.

الجمهورية اللـبـنـانية

بصفتها ممثلاً عن الاتحاد الأوروبي، تعاقدت المفوضية الاوروبية مع إتحاد شركات (كونسورتيوم) تقوده شركة اركاديس (ARCADIS Belgium N.V.) البلجيكية لإجراء تحليل للفوائد الاجتماعية والاقتصادية التي تعزز حماية البيئة في ست عشرة دولة تشملها سياسة دول الجوار الأوروبية (ENP) والاتحاد الروسي[3]. اما الشركاء الآخرون للكونسورتيوم فهم : معهد السياسات البيئية الأوروبية (IEEP)، المعهد البيئـي (Ecologic Institute) إدارة الموارد البيئة (ERM) وميتروايكونوميكا (Metroeconomica) وعدة خبراء مستقلين.

هذا هو الملخص التنفيذي للتقرير حول تقييم الفوائد في لبنان، قام بإعداده فريق خبراء يتكون من خبير الاتحاد الأوروبي وخبير وطني، وذلك باستخدام دليل تقييم الفوائد الذي تم وضعه في إطار المشروع. وقد تحول هذا الدليل، الذي كان أصلا معداً للاستخدام الداخلي فقط، الى دليل تقييم الفوائد لواضعي السياسات بغرض نشره على نطاق أوسع، والذي من شأنه المساعدة على فهم المنهجيات المطبقة في مجال تقييم الفوائد.

التحديات البيئية الرئيسية

يواجه لبنان ضغوطا متزايدة على موارده البشرية والاجتماعية والاقتصادية والطبيعية والثقافية الناجمة عن التركّز السكاني في المدن الساحلية والاتساع في التشييد والبناء التي تؤثر على نوعية النمو والحياة والعموم. وعلى الرغم من التقدم الكبير الذي احرزه لبنان في صياغة الإطار القانوني والتنظيمي والمؤسساتي، وتوفر أموال عامة كبيرة لتمويل البنية التحتية بعد انقضاء الحرب الأهلية، فهو لا يزال في بداية الطريق نحو التحول إلى مرحلة التنمية المستدامة : إن ما تواجهه وزارة البيئة من صعوبات في بسط سلطاتها وتنفيذ التزاماتها (رصد بعض مؤشرات خدمات المرافق العامة، وتقييم الأثر البيئي ، ولجان المناطق المحمية ، والبحوث وغيرها...) وما تواجهه هيئات اخرى تعنى بالبيئة مثل مرصد طرابلس للبيئة والتنمية، ومنظمات غير حكومية فضلا عن مؤسسات أكاديمية تتعاطى الشأن البيئي، من صعوبات مماثلة في تقديم الخدمات المتصلة بالبيئة التي تبدو غير منسقة وغير فعالة في بعض الأحيان. لذلك، لا يجني لبنان دائما الفوائد الصحية والبيئية والاقتصادية والاجتماعية المتوخاة، ويواجه العديد من التحديات بكافة قطاعاتها البيئية (الهواء والماء والنفايات والطبيعة) وهي قضايا في معظمها ناتجة عن أنشطة الإنسان ، والتي تفاقمت بسبب آثار تغيّر المناخ.

يزداد تلوث الهواء، سوءا في المدن الكبرى اوالمناطق الصناعية، وخصوصا في بيروت الكبرى نظراً لحركة المرور الكثيفة. وفي غياب نظم الرصد الجوي (ما عدا في طرابلس)، وعدم وجود استراتيجية للنقل، وتكاثر مولدات الطاقة الفردية أو الجماعية تعويضاً عن انقطاع التيار الكهربائي، ووجود نسبة سكان/سيارة مذهلة (3:1 مع تركيز كبير في المناطق الحضرية)، كلها امور ستفضي إلى تزايد في عدد الوفيات المبكرة وزيادة الأمراض القلبية في المناطق الحضرية، والتي من شأنها زيادة أعباء قطاع الخدمات الصحية.

في موضوع الميـاه، هناك سوء إدارة للموارد المائية وتدني لنوعية المياه السطحية بتلوثها بشكل رئيسي بالمواد العضوية، مع معالجة ضئيلة للصرف الصحي المنزلي والصناعي (19,1 ٪، مع استخراج 6 ٪ فقط من الأكسجين البيولوجي من النفايات المنزلية) في حين يتوقع حصول توازن مائي ايجابي 1090 م^3 لكل فرد في عام 2009 على الأقل حتى عام 2020. هناك فصل بين المياه السيادية واستخدام المياه في لبنان، إذ أن معظم تدفقات المياه تجري بشكل غير منظّم ولا يلبي الحاجات فقط 11,1 ٪ من تدفقات المياه بسبب إتفاقات تقاسم المياه المباشرة أو غير المباشرة واللامنصفه مع البلدان المجاورة. هذا، إضافة الى سوء إدارة خدمات المياه على الرغم من الاستثمارات الهامة لهذا القطاع منذ تسعينات القرن الماضي لتحسين رقعة خدمات المياه ومعالجة مياه الصرف الصحي، حيث لا يزال قطاع الري من اكثر القطاعات انعداماً للفعالية. إن سوء الخدمات هي التي تؤدي إلى الأمراض المنقولة عن طريق المياه، في حين يسعى معظم السكان لزيادة مصادر بديلة للمياه تفادياً لقلة كمية المياه ونوعيتها وانتظامها، بحيث يدفعون ثلاث مرات متوسط معدل تعرفة المياه.

يقترب جمـع النفايات من نسبة 99 ٪، في حين لا تزال معالجتها والتخلص منها تشكل مشكلة كبيرة من حيث الفعالية والكفاءة إذ غالباً ما يتم حرق 32 ٪ من النفايات بعد أن يتم تفريغها في الطبيعة، وبالأنهار أو بالقرب من الشاطئ؛ أما باقي النفايات 68 ٪ فيتم طمرها بأعلى تكلفة للطن في المنطقة مع عدم وجود نظام حوافز لمعالجتها. علاوة على ذلك، إن انبعاثات غازالميثان من النفايات لا يتم حرقها او حبسها بصورة منتظمة، مما يساهم في زيادة كمية انبعاثات غازات الاحتباس الحراري المحلية.

3 EuropeAid DCI-ENV/2009/225-962 (EC).

الطبيـعة. من حيث التنوع البيولوجي، تمثل المناطق المحمية البرية والبحرية 0,4 ٪ من المساحة الإجمالية. تتم إدارة 6 محميات طبيعية من أصل 10 من قبل لجان عينتها الحكومة، وذلك على الرغم من عدم انتظام التحويلات المالية التي قد تؤثر على ضمان الإدارة المستدامة للمحميات طبيعية. وتسعى المنظمات غير الحكومية تطبيق نهج التشاركية التقليدية من خلال نظام الحيما (hima) في عدد من المناطق المحمية والتي تحمل نتائج واعدة. إن إزالة الغابات في ازدياد بسبب سوء تخطيط استخدام الأراضي وتقسيم المناطق وحرائق الغابات، ولكننا نشهد تعويضاً له بجهود متزايدة للتشجير في حين لا تزال الغابات مجزأة وتمثل 13 ٪ من كامل المساحة الوطنية. وتعاني المراعي من تجزؤ متزايد بسبب ازدهار قطاع البناء، وخصوصا على طول منحدرات جبل لبنان.

ترتبط التأثيرات الناجمة عن تغيّر المناخ بتغيرات إقليمية حرارية في المكان والزمان: من زيادة في درجات الحرارة، وخفض في هطول الأمطار وانخفاض الجريان السطحي، الى توقع ارتفاع في مستوى سطح البحر، وزيادة خطر حرائق الغابات، وحدوث تغير في المؤشرات الحيوية، وزيادة كثافة وتواتر الحدث، الخ... على انه ينبغي النظر إلى ترابط هذه العوامل في سلسلة متصلة من حيث الكوارث الطبيعية لتغير المناخ من شأنها أن تؤثر بشكل رئيسي على اماكن السكن/المستوطنات، والتنوع البيولوجي، وإنتاجية المحاصيل، والمناطق الساحلية، وتسارع معدل التصحر، والعبء الصحي، وعودة ظهور الأمراض (التي تحملها الحشرات ناقلات الأمراض، والإجهاد النفسي والاجتماعي، الخ...) والهجرة. أما فيما يتعلق بمصادر الطاقة ، فقط 4,2 ٪ من إجمالي إنتاج الطاقة تعتمد على مصادر الطاقة المتجددة. ومع ذلك، هناك إمكانات كبيرة لتطوير مصادر الطاقة تتمثل بالطاقة الشمسية وطاقة الرياح والطاقة المائية.

الفوائد الرئيسية للتحسينات البيئية

ثمة فوائد كبيرة للإجراءات الفورية المتخذة لمعالجة المشاكل البيئية التي تواجه لبنان. وتشمل هذه التحسينات الصحة وخفض معدل الوفيات، وتحقيق الوفر الاقتصادي وإمكانات توفر فرص اقتصادية جديدة، وتحقيق مكاسب واسعة على صعيد رفاهية المجتمع. يقدم هذا التقرير نظرة أولية للقيمة الاجتماعية والاقتصادية المحتملة الناجمة عن هذه التحسينات في مختلف القطاعات البيئية. إن الأرقام الواردة في هذا التقرير هي فقط للدلالة، وتستند إلى تقييم سريع غالباً ما يستخدم بيانات محدودة وافتراضات كثيرة. بانتظار إجراء تقييمات تفصيلية يمكن الاضطلاع بها في المستقبل، من المتوقع أن يوفر هذا التقرير المساعدة المرجوة لدعم رسم السياسات وصنع القرارات السليمة بشأن القضايا البيئية.

تؤكد التقديرات على امكانية تحقيق العديد من الفوائد بحلول عام 2020 بشرط القيام بالاستثمارات المناسبة. إن السنة الأساس لكل مسألة بيئية مطروحة هي عام 2008 حيث تبنى على اساسها توقعات عام 2020 التي تعتمد كسيناريومألوف تتم مقارنته بسيناريو موائمة الهدف لعام 2020 بهدف استخلاص تقييم للفوائد بالنسبة لجوانب محددة نوعاً وكماً، وربما ايضاً من الناحية النقدية .

ومع ذلك، ليس من السهل بمكان تقييم جميع الفوائد البيئية نظراً لوجود ثغرات في البيانات ينبغي معالجتها من جانب السلطات والمؤسسات التنموية على حد سواء لتحسين آليات صنع القرار وللحد من الشك والالتباس، لا سيما بالنسبة لرصد مسائل مثل: تلوث الهواء ونوعية المياه السطحية والجوفية، والمياه المبتذلة، والمياه الجوفية، وتدهور الأراضي، والتخلص من النفايات الصلبة، وآثار تغير المناخ على الحيوانات والنباتات الى غيرها من المسائل؛ وبشكل أكثر تحديداً، هناك مسألة فوائد معالجة ندرة المياه التي ستصبح ملحة في لبنان بعد عام 2020 لم يتم تقييم فوائدها نقدياً وتحتاج إلى عناية خاصة.

إن تلوث **الهواء** هي من المسائل الهامة في المدن الكبيرة، وتتطلب إعادة النظر في قطاع النقل وإمكان تخفيض جزء من تلوث الهواء (حيث يتم تشغيل المولدات الجماعية والفردية في أثناء انقطاع التيار الكهربائي) مع تحسين خدمات المرافق العامة. إن المنافع التي يحصل عليها المجتمع بحلول عام 2020 تجنّب حصول 376 حالة وفاة سابقة لأوانها وتجنّب 564 حالة مرض القلب والرئتين، بالإضافة إلى تحسين المحاصيل الزراعية وتخفيف تدهور البنية التحتية والمباني في عام 2020. وتتلخص هذه الفوائد حتى عام 2020 بما يلي:

	الفوائد النوعية	الفوائد الكمية
الهواء	**الصحية:** تجنب أمراض القلب والرئتين **البيئية:** تقليل الضرر الذي يصيب النظم الإيكولوجية والاضرار الناجمة	تقليص حالات الوفيات السابقة لاوانها: 376 تقليص أمراض القلب والرئتين : 564

	الفوائد النوعية	الفوائد الكمية
	عن تغيّر المناخ **الاقتصادية:** فرص توفر التنمية البيئية وتقليص النفقات الصحية **الاجتماعية:** نوعية الحياة: فوائد اجتماعية وبيئية	تجنب تدهور البنية التحتية ؛ زيادة الانتاج الزراعي فوائد اخرى: تعزيز السياحة بنتيجة الهواء النظيف، زيادة في فرص النمو الاخضر وتوفير فرص العمل في هذا المجال، الخ.

إن توفير **الميـاه** والخدمات المتصلة بها، وتحسين جودتها وتقليل ندرتها هي من اهم المسائل التي تواجه السلطات، لا سيما وانه لم يجر تقييم نقدي للفوائد المتعلقة بندرة المياه في تقييم الفوائد على الرغم من تفاقم المشكلة المتوقعة من خلال النمو السكاني والنشاط الاقتصادي (السياحة) ، وخاصة بنتيجة تغيّر المناخ في المستقبل. إن المنافع التي ستعود على المجتمع في عام 2020 مع التغطية الشاملة للمياه وتحسين الصرف الصحي تشمل: تجنب 16 حالة وفاة من الإسهال ؛ وتجنب 1,2مليون حالة إسهال؛ تجنب 32000 حالة هضمية وتنفسية حادة متعلقة بالسباحة؛ توصيل 3,7 مليون شخص إلى شبكات الصرف الصحي؛ وزيادة فائض المستهلك للمياه الى4,6 مليون شخص بسبب تحسين الخدمات؛ و تحسين مجاري 17 نهراً حتى يصلوا إلى وضع بيئي جيد في عام 2020. وتتلخص هذه الفوائد حتى عام 2020 بما يلي:

	الفوائد النوعية	الفوائد الكمية
المياه	**الصحية:** تخفيض الأمراض المنقولة بالمياه **البيئية:** تحسين نظم المياه الايكولوجية؛ تحسين نوعية المسامك **الاقتصادية:** تخفيض تكاليف المياه وتخفيض استخدام المنازل للمياه؛ توفير المياه خاصة بالنسبة لشريحة الفقراء؛ إتاحة الفرص الاقتصادية **الاجتماعية:** تحسين نوعية الحياة: فوائد اجتماعية وبيئية؛ إعادة الثقة بين السكان ومؤسسات المياه	تجنب 16 حالة وفاة من الإسهال؛ و تجنب 1,2 مليون حالة إسهال؛ تجنب 32000 حالة هضمية وتنفسية تتعلق بالسباحة؛ توصيل 3,7 مليون شخص إضافي إلى شبكة معالجة المياه المبتذلة بمرحلتها الثانية وتحسين خدمات الصرف الصحي؛ زيادة فائض المستهلك للمياه الى 4,6 مليون شخص بسبب تحسين الخدمات؛ وتحسين مجاري 17 نهراً حتى يصلوا إلى وضع بيئي جيد في عام 2020؛ وفوائد أخرى لم يتم تقييمها مثل ندرة المياه ، الخ.

إن التخلص من **النفايـات** هي مسألة لا تزال مطروحة وبشكل خاص على طول الساحل لتلبية حاجات الناس من خلال إقامة معامل تدوير النفايات لاستعمالها في توليد الطاقة والذي من شأنه أن يجنب النقمة الاجتماعية ويجنب إقامة مطامر مكلفة للنفايات في المناطق الساحلية. ومع ذلك، فإن تقييم الفوائد لم يأخذ بعين الاعتبار إستعمال النفايات لتوليد الطاقة كخيار بديل لإدارة النفايات. إن المنافع التي تعود على المجتمع من تحسين إدارة النفايات بحلول عام 2020 هي على النحو التالي: 100 ٪ تجميع شامل للنفايات؛ 62 ٪ طمر في مواقع طمر النفايات الخاضعة للرقابة؛ و 12 ٪ إعادة تدوير؛ و 12 ٪ إنتاج أسمده؛ تجنّب 82 مليون م^3 من انبعاث غاز الميثان؛ توفير 55,4 مليون م^3 من غاز الميثان كمصدر للطاقة؛ وخلق 91 فرصة عمل. وتتلخص هذه الفوائد حتى عام 2020 بما يلي:

	الفوائد النوعية	الفوائد الكمية
النفايات	**الصحية:** تجنب وطآة التلوث الناجم عن رؤية وتنشق النفايات؛ خفض الأمراض التي تنقلها المياه الملوثة بالنفايات **البيئية:** خفض تلوث النظم الإيكولوجية من مياه وتربة والاضرار الناجمة عن تغيّر المناخ **الاقتصادية:** خلق فرص عمل وإتاحة اعمال جديدة في **الاجتماعية:** مجال تدوير النفايات، تمويل مشاريع تحد من انبعاث الغازات؛ تحسين نوعية الحياة و إعادة الثقة بين السكان والمؤسسات المضطلعة بادارة النفايات.	النفايات: 100 ٪ تجميع شامل للنفايات ؛ 62 ٪ طمر في مواقع طمر النفايات الخاضعة للرقابة؛ 12 ٪ إعادة تدوير؛ و 12 ٪ إنتاج أسمدة؛ تجنب 82 مليون م^3 من انبعاث غاز الميثان؛ توفير 55،4 مليون م^3 من غاز الميثان كمصدر للطاقة ؛ خلق 91 فرصة عمل ؛ وفوائد أخرى لم يتم تقييمها مثل تكلفة الفرصة البديلة لإستعمال الأراضي في حال تحويل النفايات إلى طاقة ، الخ.

الطبـيعـة. باستثناء الغابات، يتزايد تدهور الأراضي مع غياب اي التزام سياسي لوقف تدهور المشاعات والذى غالباً ما يعزى إلى افتقار في تنظيم قطاع البناء. اما المنافع التي تعود على المجتمع لمعالجة بعض المشاكل بحلول عام 2020 فهي: تخزين إضافي لـ100000 طن من ثاني أكسيد الكربون (CO_2)، وزيادة بنسبة 5 ٪ في المحاصيل الزراعية. وتتلخص هذه الفوائد حتى عام 2020 بما يلي:

	الفوائد النوعية	الفوائد الكمية
الطبيعة	**الصحية:** تحسين الاوضاع النفسية ؛ **البيئية:** تجنب تدهور الاراضي، زيادة في قيمة **الاقتصادية:** الاراضي وتحسن في المناخ؛ فوائد معقولة؛ تحسين المحاصيل الزراعية؛ **الاجتماعية:** تحسين نوعية الحياة: فوائد اجتماعية وبيئية .	:تخزين إضافي لـ100000 طن منCO_2 ؛ وزيادة بنسبة 5 ٪ في المحاصيل؛ وفوائد أخرى عديدة لم يتم تقييمها مثل القيمة الخيارية للمناظر الطبيعية المتميزة، الخ.

بدأت قضايا **تغير المناخ** تستحوذ على اهتمام صناع القرار مع مسألة حرائق الغابات التي شكلت إحدى الأولويات التي يتعين معالجتها. من حيث تغير المناخ، إن تنفيذ خطة جديدة للطاقة تحوي على مزيج من الغاز والنفط والطاقة المتجددة من شأنها تخفيض انبعاثات الكربون بشكل كبير؛ وقد تم احتساب فوائد الخطة التي تتراوح ما بين 504 و 560 مليون € PPP من حيث تجنب الكربون بحلول عام 2020 (على الرغم من أن الأرقام ليست مدرجة في الجدول 1) ذلك ان التحول إلى مصادر الطاقة المتجددة سوف يمثل حوالي ربع هذه المكاسب فقط. اما فوائد التكيّف التي تعود على المجتمع بحلول عام 2020 ستكون على وجه الخصوص: 20 ٪ للطاقة المتجددة يعادل تجنب2731 كيلوطن من CO_2، في حين أن الخطة الجديدة للطاقة التي تحوي على مزيج من النفط والغاز والطاقة المتجددة يعادل ما لا يقل عن تجنب 13000 كيلوطن CO_2؛ وتجنب تآكل 45080 م^2 من السواحل بفضل إدارة تآكل السواحل باتباع سياسة تدخل دفاعية ناعمة وقاسية في آن؛ والمحافظة على 103 مليون م^2 من الغابات من الحريق نظراً لتحسن الاستعدادات. وتتلخص هذه الفوائد حتى عام 2020 بما يلي:

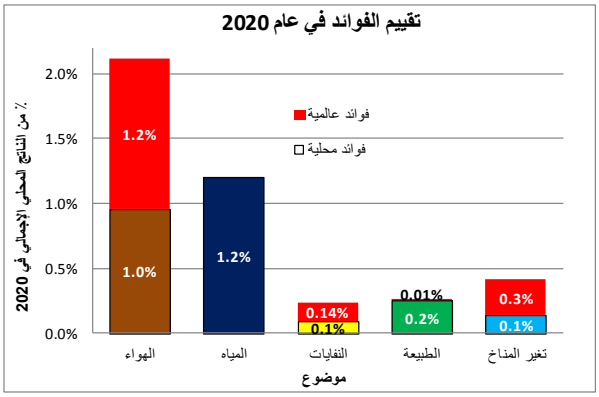
	الفوائد النوعية	الفوائد الكمية
تغير المناخ	**الصحية:** تجنب امراض القلب والرئتين؛ **البيئية:** تحسين حالة الاراضي والمياه وبيئة البحار؛ **الاقتصادية:** تجنب تآكل السواحل؛ فوائد على صعيد تغير المناخ؛ توفير فرص إضافية للقطاع الخاص؛ **الاجتماعية:** تحسين نوعية الحياة ؛ توفير الطاقة للمناطق النائية.	خفض الإنبعاثات من الوقود: 20 ٪ للطاقة المتجددة يعادل تجنب2731 كيلوطن CO_2 ، في حين أن الخطة الجديدة للطاقة التي تحوي على مزيج من النفط والغاز والطاقة المتجددة يعادل ما لا يقل عن تجنب 13000 كيلوطن CO_2؛ تجنب تآكل 45080 م^2 من السواحل؛ و103 مليون م^2 من غطاء الغابات محفوظة من الحريق نظرا لتحسن الاستعدادات لمكافحة الحرائق؛ وفوائد أخرى عديدة لم يتم تقييمها مثل خطورة التصحر، الخ.

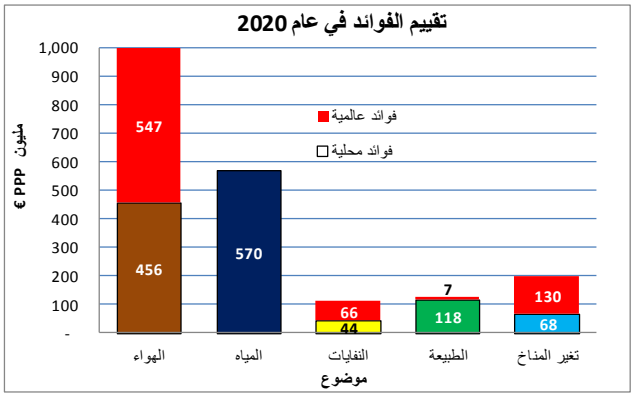
إن **الفوائد النقدية** التي تم تحليلها في هذا التقرير لا تشكل الا قسم من الفوائد لتي يمكن أن تعود على المجتمع من تحسين السياسات البيئية. يستخلص من التحليلات التي أجريت ان الفوائد الاولية المحلية والعالمية قد بلغت 2 مليار بسعر الصرف المعدل بالقوة الشرائية لليورو (€ PPP) أي بنسبة 4,2 ٪ من الناتج المحلي الإجمالي في عام 2020 (الجدول رقم 1 و الرسم رقم 1).

الجدول رقم 1 : تقييم المنافع النقدية المحلية والعالمية --لبنان، مليون € PPP و٪ من الناتج المحلي الإجمالي عام 2020

موضوع	على الصعيد الوطني		على الصعيد العالمي		المجموع	
	مليون € PPP	٪ من الناتج المحلي الإجمالي في2020	مليون €	٪ من الناتج المحلي الإجمالي في2020	مليون € PPP	٪ من الناتج المحلي الإجمالي في2020
الهواء	456	1,0%	547	1,2%	1.003	2,1%
المياه	570	1,2%			570	1,2%
النفايات	44	0,1%	66	0,14%	106	0,2%
الطبيعة	118	0,2%	7	0,01%	125	0,3%
تغير المناخ	68	0,1%	130	0,3%	198	0,4%
المجموع	**1.256**	**2,6%**	**750**	**1,6%**	**2.006**	**4,2%**

الرسم رقم 1 :تقييم المنافع النقدية المحلية والعالمية --لبنان، مليون € PPP و٪ من الناتج المحلي الإجمالي عام 2020





تم تقييم الفوائد الاولية المحلية وقد بلغت 1,26 مليار € PPP أو ما يعادل 1,6 تريليار ليرة لبنانية، اي بنسبة 2,6 ٪ من الناتج المحلي الإجمالي في عام 2020، مع احتساب النسب التالية لإجمالي الفوائد: الهواء (36,3 ٪ من إجمالي القيمة) والمياه (45,4 ٪) والنفايات (3,5 ٪) والطبيعة (9,4 ٪) والمناخ (5,4 ٪). اما فيما يتعلق بالقضايا العالمية، فقد بلغت الفوائد العالمية 0,75 مليار (€) في عام 2020 مع النسب التالية : الهواء (72,9 ٪ من إجمالي القيمة)؛ تجنب الانبعاثات) والمياه (0 ٪) والنفايات (8,8 ٪؛ تجنب الميثان) والطبيعة (0,9 ٪؛ تجنب إزالة الغابات) والمناخ (17,3 ٪؛ بإضافة مزيج من مصادر الطاقة المتجددة).

التوصيات

إن تقييم الفوائد العملية المنهجية الحالية هي عبارة عن جهد أولي من أجل مساعدة البلدان التي تدخل ضمن إطار سياسة الجوار الأوروبية في تعميم هذه الأداة، وصقلها، وتحسينها، وتحديثها بشكل منتظم، كما لدعم عملية صنع القرار فيما يتعلق بقضايا التنمية المستدامة المحلية والعالمية. الأهم من ذلك، هناك الآن فرصة هامة لتحديد البدائل الأكثر فعالية من حيث التكلفة والكفاءة والإنصاف (الاستثمارات المثلى) لتحديد وتنفيذ سياسات تدخلية رئيسية للوصول إلى الأهداف التي حددها تقييم الفوائد في مختلف القطاعات البيئية المختلفة. في الواقع ، هذه الجهود لن تجني مكاسب محلية صحية وبيئية واقتصادية واجتماعية فحسب، بل تعتبر بمثابة استجابات التكيف والتخفيف من الآثار المستقبلية لتغير المناخ.

يمكن تحديث نتائج تقييم الفوائد على أساس سنوي من قبل وزارة البيئة بالتعاون مع الإدارة المركزية للإحصاء، وربما ايضاً وزارة المالية باستخدام المنهجية التي وضعها برنامج تقييم الفوائد. لذلك، فإن تقييم الفوائد متاح بسهولة في كل عام لصناع القرار في القطاع بغية إدخال عامل الفوائد البيئية ضمن برامج ذات أولوية قصيرة وطويلة المدى.

تُبين الثغرات في البيانات التي ظهرت في مختلف المواضيع البيئية، الحاجة إلى بناء منظومة بيانات بيئية متكاملة عبر الوزارات الرئيسية والوكالات التي يمكن اعتبارها كمدخل لتعميم الفوائد البيئية في مختلف القطاعات. ويمكن اعتبار المؤشرات التي تم وضعها في قائمة تقييم الفوائد كقاعدة للمؤشرات التي سيتم الأخذ بها تدريجيا وستجمع عبر الوزارات والوكالات تحت إشراف الإدارة المركزية للإحصاء بالتعاون مع وزارة البيئة. إن عملية تقييم الاحتياجات مضمونة عن طريق الاستفادة من المجموعة الحالية التي تم تحسينها بدعم من برنامج مكتب الإحصاء الأوروبي لتحديد الثغرات في المؤشرات (الأجهزة والبرمجيات)، وتحديد المسؤولية لجمع المؤشر في كافة القطاعات، ووضع نظام إحصائي بيئي يتولى مسؤوليات إدارية ومزود بوسائل النشر. علاوة على ذلك ، يمكن دمج نظام البيانات البيئية هذا في إطار شبكة أوسع للبيانات الإحصائية التي يمكن أن تغذي نظام المعلومات الجغرافية (GIS) المتعدد الطبقات والذي من شأنه تزويد صانعي القرار بنظام افضل لدعم اتخاذ القرار في مجال حماية وإدارة الموارد الطبيعية.

وضعت الحكومة اللبنانية في الآونة الأخيرة عددا من السياسات والاستراتيجيات والخطط الرئيسية والمبادئ التوجيهية التي يمكن أن يبنى عليها لممارسة تقييم الفوائد: وزارة الطاقة والمياه (اعتمدت في عام 2010)، وزارة الطاقة والمياه- مشروع مياه الصرف الصحي والري (مشروع 2011)، وزارة البيئة – مشروع النفايات الصلبة (صدق في عام 2010)، وزارة البيئة بالتعاون مع برنامج الأمم المتحدة الإنمائي – إغلاق وتأهيل المطامر غير الصحية (مشروع 2011)، مجلس الإنماء و الإعمار- تخطيط استخدام الأراضي (صدق عام 2009)، وزارة البيئة بالتعاون مع مرفق البيئة العالمية GEF وبرنامج الأمم المتحدة الإنمائي- التقرير الوطني الرابع لاتفاقية التنوع البيولوجي (2009)، وزارة البيئة بالتعاون مع البنك الدولي- التحليل القطري للبيئة (2011)، وزارة البيئة بالتعاون مع برنامج الأمم المتحدة الإنمائي - تقريرحالة البيئة السنوي

(2011)، وزارة البيئة بالتعاون مع مرفق البيئة العالمية وبرنامج الأمم المتحدة الإنمائي- التقرير الوطني الثاني لإتفاقية الإطار للأمم المتحدة حول تغير المناخ (2011). ولذلك، هناك فرصة لتحريك تحليل تقييم الفوائد ودفعه إلى الأمام عن طريق احتساب كل الفوائد المتأتية من الخيارات الواردة في مختلف الاستراتيجيات، والخطط الرئيسية والمبادئ التوجيهية التي من شأنها مساعدة الحكومة على تحديد الأولويات وإتخاذ الخيارات الأكثر فعالية وكفاءة وإنصافا لتعزيز النمو الاخضر والمستدام.

إن التعامل مع تأثيرات تغير المناخ، إنما هي مسألة بقاء حتمية وعالمية؛ إلا انه يمكن لهذه التأثيرات إن تعطل بسهولة مسائل تنموية محلية هامة وخيارات السياسات العامة. في الواقع، إن سوق الكربون الأوروبي لتبادل المعلومات مهم لسعر الكربون الذي يمكن أن يعطي إشارات مباشرة إلى المستثمرين الأوروبيين المهتمين بالاستثمارات البيئية المحلية التي تجني فوائد الكربون الهامشية. ومع ذلك، يمكن للفوائد العالمية من الاستثمار في الكربون أن تشوه الفوائد المحلية للاستثمار في المسائل المتصلة بالبيئة (مثل المياه) مع القليل من القيمة المضافة للكربون (إدارة رواسب الصرف الصحي) او بدونها. وبالتالي، ينبغي إعادة التوازن بين الأولويات البيئية العالمية والمحلية من قبل حكومات سياسة دول الجوار الأوروبية وبالتعاون مع شركاء التنمية لمنع مسار تنموي أحادي قد يلحق الضرر بالفقراء بشكل رئيسي.

الطـريق إلـى الأمـام

عموماً، يمكن للدراسات المستقبلية حول الفوائد التركيز على مجالات حيث الحاجة إلى الاستثمار المباشر من أجل تقييم الحلول التي سيكون لها فوائد أعلى. هذه الدراسات يجب أن تأخذ بالاعتبار الطابع الإقليمي لبعض المشكلات البيئية الملحة. على سبيل المثال، يرتدي تلوث الهواء اهمية خاصة في المناطق الحضرية؛ إدارة الموارد المائية وموثوقية المياه إنما هي قضية ملحة في جميع أنحاء البلاد؛ بالاضافة الى إدارة النفايات الصلبة. مثل هذه الدراسات ينبغي إجراؤها بالتعاون مع خبراء محليين، الأمر الذي يتيح أيضا أخذ القضايا الاجتماعية والتنموية على نحو أوثق في الاعتبارات المستقبلية (مثل الآثار المترتبة على استخدام الرسوم وغيرها من أدوات السوق القائمة، والصلة بين الفقر وتدهور البيئة) .

ينبغي التشديد على الفوائد المباشرة للسكان المحليين (كزيادة الدخل وخلق فرص العمل للفقراء، إنشاء المؤسسات الصغيرة والمتوسطة) والعلاقة بين التحسينات البيئية والتنمية المستدامة. وينبغي أيضا التأكيد على اهمية الفوائد الاقتصادية، مثل التشديد على إنشاء صناعات بيئية (خضراء)وخلق الأسواق.

ويمكن إدراج معايير أخرى و/ أو مواضيع فرعية للتحليلات في المستقبل، مثل: إعادة استخدام المياه، وتلوث المياه الجوفية والقضايا العابرة للحدود (كجزء من "نوعية المياه السطحية")، والحد من استخدام الموارد المتحجرة (المستحاثات)، واستعمال الطاقة بفعالية والنقل ذات الصلة بانبعاثات الغازات الدفيئة (كجزء من "تخفيف آثار تغير المناخ"). ثمة عوامل اخرى قد تستفيد من إدراج مؤشرات إضافية عندما تصبح البيانات متاحة، مثل إدراج الجسيمات (الناعمة) أو الـ$PM_{2.5}$، والأمونيا (NH_3) خاصة بالنسبة لمعمل سلعاتا، والهيدروكربونات (HC) في إطار عوامل زيادة "جودة الهواء". ويمكن توسيع رقعة الآثار والفوائد، فعلى سبيل المثال يمكن إدراج تحليل اكثر تفصيلاً حول الكسارات او حول أثر تغير المناخ على تواتر وكثافة الرواسب، والإنتاجية الزراعية، والهجرة وتوافر الأغذية (كجزء من عامل "التكيف").

يمكن للدراسات المستقبلية أن تتطرق إلى التدابير الممكنة لتحقيق الأهداف، سواء أكانت عالمية أو وطنية فعلية. وسيكون هناك حاجة إلى مزيد من التحليل حول القدرات المؤسسية وبشأن الخيارات التكنولوجية، والبنية التحتية والقانونية والاستراتيجية. ويمكن استكمال هذا العمل من خلال بناء القدرات والحلقات التدريبية لتحفيز تحديد الأولويات والتنفيذ الفعلي للتدابير التي تم تحديدها.

ANALYSIS FOR ENP COUNTRIES ON SOCIAL AND ECONOMIC BENEFITS OF ENHANCED ENVIRONMENTAL PROTECTION

Country report: Republic of Lebanon

1 INTRODUCTION

1.1 This report

The European Union, represented by the European Commission contracted a consortium led by ARCADIS Belgium N.V. to undertake an assessment of the social and economic benefits of enhanced environmental protection for the 16 European Neighbourhood Policy (ENP) countries and the Russian Federation. The other consortium partners are: Institute for European Environmental Policy (IEEP), Ecologic Institute, Environmental Resources Management Ltd., Metroeconomica Ltd., and several independent experts.

The overall aim of the project is to move environmental issues higher up on the political agenda. Its specific objectives are to improve awareness of the benefits of enhanced environmental protection within the countries under study and of their capacity to assess these benefits. In this way, the project is meant to encourage each country to integrate environmental considerations into policy making and to mobilise the necessary financial resources for environmental improvements.

This report provides an assessment of the environmental, social, health and economic benefits of environmental improvements in Lebanon with a 2020 target (with interventions) compared to a 2020 baseline (without intervention) that is projected from the 2008 baseline.

This report has been prepared by a Fadi Doumani and Hanadi Musharrafiyeh.

This report has been prepared on the basis of information gathered during a country mission, which was undertaken by the authors in September 2-7, 2010 and during follow-up meetings with country officials, complemented with a desk review of national and international databases and reports.

1.2 What are environmental benefit assessments?

An environmental benefit assessment (BA) examines the potential positive outcomes for society that result from the adoption of environmental protection targets and the implementation of environmental actions to meet these targets. Such actions, which include environmental policies, legislation and investments undertaken by government, industry or other stakeholders, could lead to environmental improvements (e.g., improved water quality from the construction of water treatment plans).

The environmental BA undertaken for Lebanon 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 although these are not costed in this report;
- the identification, and where practical, quantification and monetisation of the benefits arising from such an environmental change.

The methodology applied for the country BAs was developed under the project, building on previous analyses and methodologies, in particular on IEEP's ENP methodology (ten Brink and Bassi, 2008) and the World Bank's Cost of Environmental Degradation reports.[4]

The methodology is described in a Benefit Assessment Manual that was used by the project experts.

The Benefit Assessment Manual for internal use has been developed into a Benefit Assessment Manual[5], for a wider audience of policy makers in the ENP countries. This Benefit Assessment Manual provides an in-depth understanding of the methodologies applied under the project and can be downloaded from the project's website www.environment-benefits.eu. Estimates and calculations by the authors in this report, are made on the basis of the methodologies described in this Manual.

1.3 Aims of this country benefit assessment

This benefit assessment report intends to help the country 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 assessment provides "order of magnitude" results, in order to communicate the scale and significance of the potential benefits of taking action.

This benefit assessment report aims 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.

This benefits assessment report can also play an important role in raising awareness regarding environmental problems, impacts and the benefits of action. 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 this report can stimulate policy attention, focus, action and appropriate funding.

4 World Bank website: <www.worldbank.org>.
5 Bassi et al. (2011).

1.4 Potential users of and target audience for this benefit assessment report

The potential users of and the target audience for this benefit assessment report include:

- Governmental institutions, responsible for a sector that will directly benefit from environmental improvements, such as the 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 funding environmental actions and for environmental policy integration.[6]
- Regional and local authorities, for similar reasons as the above mentioned governmental institutions.
- Finance ministries, which often 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.
- Parliament: this report can help legislators responsible for environmental matters to make the case for better environmental protection and conservation legislation.
- The Judiciary (ministries of Justice) and environmental inspectorates/enforcement agencies. This report provides evidence that supports their arguments for enforcing environmental legislation.
- Communities: this report 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, which jointly work on the common challenge of the transition to a resource efficient, effective, green and equitable economy. This report can help them to set priorities for action and provides evidence when advocating for enhanced environmental protection.

1.5 The benefits of an improved environment

The country BA focuses on four categories of benefits from environmental improvements that are listed in Box 1-1.

6 Environmental 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.

Box 1-1 Benefits associated with environmental improvement	
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; and – a reduction in respiratory and cardio-pulmonary diseases and premature mortality associated with poor air quality.
Environmental benefits	They are the positive impacts on the natural environment of meeting environmental 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, avoidance of eutrophication that can lead to biodiversity loss and freed up natural resources that will have an increase ecological service impact (water cycle).
Economic benefits	– 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); – lowered treasury transfers to power utilities when public or private renewable energy is favoured – 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); and – increased employment through environmental investments (e.g., potential from developing the waste collection sector, from growth in eco-tourism).
Social benefits	– the safeguarding of, and access to, the natural and cultural heritage (avoided pollution damage to historic buildings or the destruction of historic landscapes); – recreational opportunities (e.g., ecotourism, fishing and bathing); – benefits of trust in quality environmental service provision (e.g., water quality); and – social cohesion due to support for employment, social learning and the development of civil society (due to increased information provision, consultation and involvement).

Source: see the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

1.6 Scope of the country benefit assessment

The improvement of environmental conditions encompasses a vast range of environmental areas and policies. Clearly not everything can be covered by the project, and a selection of the key environmental issues on which the analysis should focus on was made.

The aim was to identify issues of importance which are sufficiently representative of the five environmental themes covered by the project, i.e., Air, Water, Waste, Nature and Climate Change (as a horizontal area), which are common across the countries under study and which are sufficiently simple to be assessed rigorously.

To this end, the five themes have been sub-divided into *sub-themes,* which are representative of key pressures or states of each theme. Hence, for each sub-theme, smaller categories called *parameters* have been identified. The BAs are about assessing the benefits of improvements for each of these parameters. Other parameters could as well be covered

in case studies (such quarries or coastal zone encroachment) but are not mentioned in Table 1-1 that provides an overview of the main themes, subthemes and parameters.

Table 1-1 Overview of themes, sub-themes and parameters

Theme	Sub-theme	Parameter
AIR	Air quality	Ambient air quality
WATER	Water - infrastructure and practice	Connection to safe drinking water
		Connection to sewage network and hygiene conditions
		Level of waste water treatment
	Water - natural resources	Surface water quality *(that affects underground water quality)*
		Water resource scarcity
WASTE	Waste collection	Waste collection coverage
	Waste treatment	Waste treatment
		Methane emissions from waste
NATURE	Biodiversity	Level of biodiversity protection
	Sustainable use of natural resources	Deforestation levels
		Level of cropland degradation *(that could be affected by over-mining)*
CLIMATE	Climate change drivers	Deforestation *(covered under nature)*
		Methane emissions from waste *(covered under waste)*
	Climate change responses	Uptake of renewable energy sources
		Climate change adaptation

1.7 The level of analysis

The BAs provide "order of magnitude" results, in order to communicate the scale and significance of the potential benefits.

The benefits arising from improved environmental conditions can in principle be analysed in three ways:

- **Qualitatively,** providing a description of the nature of the benefit, the people, land areas, sectors and services affected. This the easiest approach and is applicable to all the parameters analysed.
- **Quantitatively,** 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 can lead to a quantifiable reduction in the likely number of cases of respiratory disease and associated morbidity or early mortality. This approach 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.
- **Monetarily,** when possible. This third approach multiplies the quantitative benefit identified by a standard economic value (or ranges) representing the monetary value for society of a certain environmental improvement.

Such value can for instance be:

- the amount of money saved if a certain improvement is made (e.g., avoided hospitalisation costs from avoided illness; reduced cost for water purification if the quality of water improves);
- market values of products or savings (e.g., increased fish output, carbon storage); or
- a measure of people's willingness to pay (WTP) for a benefit (e.g., access to improved bathing water quality).

Such economic values may be obtained from:

- cost data for specific services (*e.g.,* hospital treatments for particular diseases);
- market values for particular commodities (e.g., fish, carbon);
- survey data documenting actual willingness to pay responses;
- modelling studies; and
- applying a benefit transfer study (i.e., drawing upon valuation study results calculated elsewhere, that value similar changes).

Most benefits are identifiable in qualitative terms, but due to data availability, only a subset of them in quantitative terms and a smaller set in monetary terms.

The adoption of this three-level approach is important as the availability of suitable data varies between each parameter to be measured and between countries. The purpose of this three-stage approach is to ensure that the full range of benefits arising from enhanced environmental protection is realised and that the BA is not constrained by focusing only on the elements that can be quantified or monetised.

In general, the aim is to have a national picture for each parameter, but in some cases, local case examples can be valuable to help communicate particular benefits. To this extent, a case study has been included in this report for the water theme (see Section 1).

1.8 Overview of key valuation terminology

For the case study, the calculation of the benefit arising for the improvement of water supply services in terms of quality, quantity and reliability is based on the reduction of the defensive and supplemental actions as stated preference surveys produced willingness to pay values (less than 50% increase in tariffs) less than the effective household spending on water (3 times the tariff). Hence, the difference between the new suggested tariff that will improve service delivery and the household water multi-source 2020 baseline cost is calculated to generate the benefits should water service effectiveness, efficiency and equity improvement be achieved.

1.9 Assumptions

A number of assumptions have been made to carry out the country BA, as outlined in Table 1-2. Parameter specific assumptions are included in the relevant sections of this report.

General assumptions, across parameters, are summarised in the following table. It should be noted that a practical approach with limited sensitivities has been chosen for this study in order to keep the analysis relatively simple.

Table 1-2 Summary of key assumptions for ENP benefits studies

Issue	Assumptions
Timescale	2020
Exchange rate	€ 1 = Lebanese pound (LP) 2,206.0 (2008 and 2020); € PPP 1 = Lebanese pound (LP) 1,294.2 (2008 and 2020); € PPP 1 = € 1 (2008 and 2020) in the Euro Zone for the Carbon Market; and US$ 1 = Lebanese pound (LP) 1,507.5 (2008)
Reference year	2008 if and where data available, and note year if other than 2008.
Targets	Usually a single common target for year 2020 used across the countries for each parameter under analysis.
Baseline	Usually a set of essential factors are included in the baseline projection, such as GDP, population and their growth rates. These are kept to a minimum to keep the analysis reasonably simple.
Adjustment of monetary values for Purchasing Power Parity (PPP)	Monetary values are adjusted for Purchasing Power Parity (PPP), except for the carbon prices used as regards climate change mitigation, which are in €. Monetary values calculated using national values (e.g., health benefits associated with avoided impacts of air pollution, or other preferences) are thus in € PPP. 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.
Mortality and morbidity	Improvements in e.g., ambient air quality, drinking water, sanitation and hygiene are associated with reductions in the risk of mortality. The benefits to society of mortality risk reductions are usually valuated by people's willingness-to-pay (WTP) for such risk reductions. WTP is then converted to a value of statistical life (VSL) that is applied to estimated cases of mortality avoided from the environmental improvements to arrive an estimate of the monetary benefits of the improvements. The VSL varies across countries in proportion to GDP/capita (PPP terms).[7] It should be emphasized that these VSLs have nothing to do with value of life, but rather reflects how people are willing to reallocate their resources from consumption of market goods and services to paying for reductions in the risk of mortality. The same WTP and benefit transfer approach is used for valuing an avoided case of illness, unless otherwise stated.
Time development of willingness to Pay (WTP)	Assumes a proportional relationship – e.g., if GDP/capita goes up by a factor of two, the WTP goes up by a factor of two.

Source: World Bank (2010); Oanda website: <www.oanda.com>; See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011).

7 An empirically estimated function from a recent meta-analysis of studies of VSL in over 30 countries (of which nearly half are countries with a GDP per capita in the range of that of the ENPI countries) by Navrud and Lindhjem (2010) prepared for the OECD are used to estimate VSL in ENPI countries (www.oecd.org/env/policies/VSL).

The annual growth rate values used to estimate the projected 2020 values are given in Table 1-3. These are default values based on OECD estimates. For simplicity, the same factors have been used for macro regions (ENP South, ENP East and Russia) under the broad assumption that these will face similar socio-economic developments. For the waste parameters, different values have been used and referenced in the appropriate sections.

Full reference to the specific values used for issues such as GDP, population, growth rates and Values of Statistical Life (VSL) for each country, as well as Willingness to Pay (WTP) values and carbon values common across all countries have not been included in this report, but can be found in the Benefit Assessment Manual that has been developed for the project.

Table 1-3 Annual growth rates

Country cluster	Data	Annual growth factor
ENP South	**population**	**1.68%**
	GDP	**3.75%**
	GDP/capita	**2.03%**
ENP East	population	0.02%
	GDP	3.35%
	GDP/capita	3.33%
Russia	population	-0.55%
	GDP	3.75%
	GDP/capita	4.32%

Where: ENP South = Algeria, Egypt, Israel, Jordan, Lebanon, Libya, Morocco, Syria, Tunisia, West Bank and Gaza
ENP East = Armenia, Azerbaijan, Belarus, Georgia, Moldova, Ukraine.
Russia = Russian Federation.
Source: unless otherwise indicated in this report, GDP projections are based on the GDP projections used in the global modeling runs (using the Globio-Image model) for the OECD 2008 Global Outlook to 2030 report[8].

1.10 Structure of the report

The report is structured around the five themes covered by the project that are preceded by an introduction that covers the major socioeconomic and environmental issues:

- Air
- Water
- Waste
- Nature and
- Climate Change

Each theme is further divided into parameters, which break down the four kinds of benefit analysis into the range of sub-themes as listed above. A case study on water supply service improvement complements the thematic analysis.

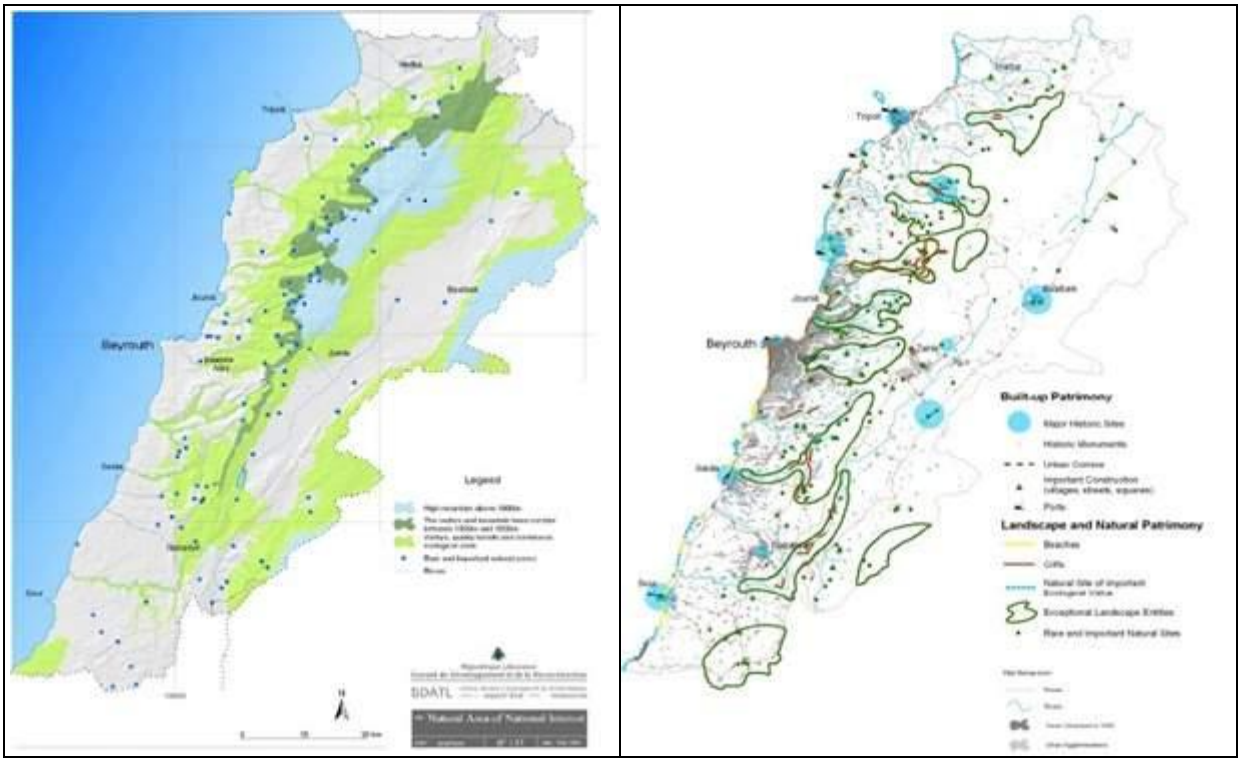
[8] OECD (2008) *Organisation for Economic Cooperation and Development: Outlook to 2030.* Paris.

2 COUNTRY OVERVIEW: LEBANON

2.1 The environment

Lebanon enjoys a unique landscape with narrow fertile plains on the coastline and between the Mount Lebanon and Anti-Lebanon parallel ridge mountains that are important factors for tourism attraction especially from the Gulf countries. A number of micro-climates and a rich natural resource endowment, consisting of abundant water resources (17 perennial and 23 seasonal rivers), diverse soil quality, and biodiversity: forests (13% of the Lebanese territories); vegetation (4,633 species of plants); and animals (4,486 species), make for a varied landscape that plays a major role in maintaining the natural continuity between the mountain ranges and other remarkable natural entities including the 230 km-long coast. The zones of ecological continuity and their vulnerability are illustrated in Figure 2-1 as 10 Nature Reserves (under the MOE jurisdiction) and 9 Protection of Sceneries and Natural Sites (under the Ministry of Agriculture) exist.

Figure 2-1 Natural Domains of National Interest and Vulnerability Areas – Lebanon



Source: NPMPLT (2005).

The Ministry of Environment (MOE) was established in 1993 with the aim of dealing with the accumulated pressures emanating from the aftermath of the Lebanese Civil War (1975-1989) and the future pressures associated with the post-war reconstruction and development drive. With little financial means (budget of LP 3 billion per year over the last decade mainly to cover administrative expenses), limited human resource capacity (54 titularised technical staff), a poor environmental governance system and an unfinished Framework Law 444/2002 for the Protection of the Environment as a number of important application decrees upstream (Environmental Impact Assessment and Strategic

Environmental Assessment) and downstream (e.g., ecotax such as the Polluter Pays Principle and carbon funding although the Kyoto Protocol was ratified by Lebanon) are still pending, it remains difficult for the MOE to properly perform its prerogatives and obligations.[9] An EC-funded environment-related legal, regulatory and institutional assessment performed by the MOE[10] helped identify 750 legislative texts with some bearing on the environment, and determined that the existing legal, regulatory and institutional framework is antiquated and fragmented with a number of overlapping responsibilities and functions with regards to the management of natural resources.

There has been a growing pressure on the environment since the end of the Lebanese Civil War that was exacerbated by the 2006 War with Israel (notably the oil spill and the construction debris) with the main issues pertaining to: air pollution hot spots especially in urban areas and industrial clusters (e.g., Selaata-Chekka); stress on water resources; low waste water connection and treatment that is affecting watersheds and the marine environment; poor solid waste disposal management; poor natural resources management and land use; a growing concern about the increased intensity and frequency of the effects of the natural disaster-climate change continuum (droughts, heat waves, forest fires, etc.).[11]

Pressures on the environment were reviewed in the EC draft 2006 National Environmental Action Plan with waste water, air, water and solid waste equally raking first. Effects were calculated in the World Bank's national COED (3.7% relative to GDP in 2005), COED resulting from the war with Israel (3.6% relative to GDP in 2006) and the COED of the northern coastal zone (4.2% relative to northern GDP in 2005) with environmental categories ranked in monetary order of magnitude for the national calculation (highest to lowest): water, air, coastal zone and cultural heritage, soil and wild life, global environment, and solid waste. The Environment Performance Index, which benchmarks the environmental performance of a country relative to other countries,[12] ranks Lebanon 90 among 163 countries with a score of 57 in 2010, which illustrates poor environmental performance.

Lebanon formulated a land use strategy, the 2004 National Physical Master Plan of the Lebanese Territories (NPMPLT) that was finalised in 2004 and adopted by the Council of Ministers in 2009 with the aim of: (i) defining Lebanon's potential assets; (ii) determining Lebanon's comparative advantages by region; and (iii) establishing Lebanon's position in a rapid globalizing world over the next decades (Figure 2.1).[13] If implemented, the strategy could significantly reduce the pressures on the environment in the future. Yet, this should be complemented by a strategic adaptation by different actors to increasingly challenging environmental issues.

2.2 Economy and society

With a current population estimated at 4.2 million in 2008 (including the Palestinian refugees), Lebanon's population density is one of the highest in the Middle East (407 people per km^2 of land area) with a large concentration of the population and the economic activity

9 World Bank (2011).
10 SELDAS (2008).
11 World Bank (2011).
12 Esty and Levy (2010): the lower the score, the better.
13 METAP (2009b); and NPMPLT (2005).

along the coastal corridor (1,620 km^2) and in urban areas: urban sprawl has created a large urban-rural agglomeration continuum hosting a population ranging between 65%[14] (*de jure* based on city boundary) and 87%[15] (*de facto* including sprawling belts) according to different citations. Nevertheless, the population growth is the lowest in the Middle East and reached 1.16% in 2007 and is projected to maintain its contraction due to a growing emigration trend that is exacerbated by the growing political uncertainty and the lack of opportunities (Table 2-1). Moreover, 28% of the population was poor in 2005[16] with the highest prevalence in the north (peri-urban Tripoli, Akkar and Hermel) and this poverty prevalence has grown with the prevailing political unrest that has persisted since 2001.

Table 2-1 Key economic indicators - Lebanon

Indicator	2008 (unless otherwise specified)
Country surface area	10,452 km^2 of which: 10,225 km^2 (land area). Yet, since the ratification of UNCLOS in 1995, the marine area (territorial waters, contiguous zone and EEZ) is about 19,516 km^2
Population	Current: 4.2 million including the Palestinian refugees Projections (2020): 4.6 million (based on a +0.7% growth)
Population and growth rate (difficult to assess as migratory trends are altering the projections)	Current: +1.16% Projections (next 5 years and 2020): NA
Number of households	Current: 991,687 Projections (2020): NA
GDP (market prices and PPP)	Current: € 20.0 billion and € PPP 34.1 billion Projections (2020): € 27.8 billion € PPP 47.4 billion (+3.75%)
GDP/capita (market prices and PPP)	Current: € 4,766 and € PPP 8,128 Projections (2020): € 6,066 and € PPP 10,345 (+2.03%)
Share (%) of agriculture in GDP	Current: 6.7%; and 4.9% in 2009
Share (%) of market services in GDP	Current (2009): 31.4% including tourism
Share (%) of construction in GDP	Current (2009): 13.2%

Note: Exchange rate used: € 1 = LP 2,207.0 (2008 and 2020); and € PPP 1 = LP 1,294.2 (2008 and 2020).
Source: CAS/MOSA (2008); World Bank (2010); See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

The strong economic recovery after the end of the Civil War was driven by construction, tourism, trade, and financial services but slowed down after the initial boom of post-war reconstruction from 8% in 1987-1997 per year to zero in 2006 mainly due to the aftermath of the July 2006 War with Israel though it bounced back since and is projected to reach again 8% in 2010 with however a reduction to 4% on average during the 2011-2015 periods (Table 2-1).[17] Nevertheless, the economic growth since the end of the Civil War underscores a double whammy: a rapid accumulation of gross public debt to unsustainable levels reaching US$ 52.4 billion in 2010, excluding the debt of the Banque du Liban, payment arrears and loans directly contracted by public entities; and Lebanon is displaying a negative trend with regards to genuine savings (-11% relative to the Gross National Income in 2009), which reflects the decline of the value of the net change in the whole range of assets that are

14 Derived from the Regional Water Establishments as urban areas have 100% water coverage and the NPMPLT (2005) suggests 64% of the Lebanese live in agglomerations in 2000.
15 World Bank (2010) although the figure seems exaggerated.
16 Laithy and et al. (2008).
17 IMF (2010).

important for sustainable development: produced assets, natural resources, environmental quality, human resources, and foreign assets.[18]

18 World Bank (2011).

3 BENEFITS OF IMPROVING AIR RELATED CONDITIONS

The emissions data used in this chapter to construct the baseline and policy scenarios for 2020 were taken from the EDGAR Database held by the EC Joint Research Centre.[19] *This data was used in all the 16 ENP country-level analysis of air quality benefits under this project. The data is constructed using a modeled approach to national emissions and therefore does not rely on observed data. The use of this data therefore allows comparison between countries since a common approach has been used to estimate the emissions. Similarly, use of this data allows analysis of important components of air pollution where national air monitoring and statistical systems do not allow observations to be made. Clearly, wherever required, further analysis can exploit records of observed emissions where these are judged to be more accurate.*

3.1 Introduction to air quality issues

Air pollutants may be released by either stationary sources (*point* source emissions), such as those emitted from the stack of a power plant, or by moving sources (*line* source emissions), which include, for example, motorcycles, automobiles, buses, trucks, rail and ship transport. Common pollutants include particulate matter,[20] nitrogen oxides (NO_x, including NO and NO_2 species), sulphur dioxide (SO_2), carbon monoxide (CO), carbon dioxide (CO_2), ozone (O_3), lead (Pb), mercury (Hg), nitrate and sulfate aerosols,[21] and carcinogenic substances, which include several heavy metals (nickel, cobalt, chromium, arsenic), benzene, dioxins and furans, polycyclic-aromatic-hydrocarbons (PAH), just to name a few.

In the present context, a physical impact is defined as a physiological response or reaction to an environmental stimulus, which is triggered by a pollutant emitted into the surrounding atmosphere. For this report, anthropogenic emissions are considered. The report thus focuses only on those pollutants emitted to the ambient air due to human related activities (anthropogenic emissions). Once in the environment, pollutants are transported away from the source via different dispersion routes, including air, water, soil and uptake by living organisms (plants and animals). For the case of airborne dispersion, pollutant uptake in humans may occur via three separate pathways: inhalation, ingestion and skin absorption. Emissions to water and soil environments and exchanges between these media and air will not be considered here. We will thus only consider air pollutants that directly impact on a receptor population.

19 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.

20 Typically, reported as total suspended particles (TSP) or suspended particulate matter (SPM). A particle or an *aerosol particle* consists of several chemical entities which are held together by inter-molecular forces and, in effect, act as a single solid or liquid unit under normal atmospheric conditions. A complete description of particulate matter requires specification of the chemical composition of its constituents and morphology (size and shape). Particles are usually identified as PM_x, where x stands for the largest aerodynamic diameter (actual or equivalent) of the collective group of particles, measured in microns (a millionth of a meter).

21 Nitrate and sulfate aerosols are secondary particulates formed in the atmosphere following chemical transformations in which NO_x and SO_2 species react with other substances already present in the air, such as, for example, ammonia.

Air pollution causes a wide range of human health 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, ecosystems 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.

This section will cover the following aspect of air quality: ambient air quality.

3.2 Benefits from improved ambient air quality

3.2.1 Current state

Lebanon has not formulated a strategy for air pollution management yet and the legislative, institutional and regulatory framework is almost inexistent despite the formulation of a draft law for the protection of air quality and sporadic measures to reduce air emissions from the transport and industrial sectors. In Lebanon air pollutants result principally from stationary sources and from transport. For example, Lebanon emitted 83,000 tons of SO_2 in 2008: 54.2% from the power sector, 31.0% from heavy industry, 10.8% from transport, and 4% from other industry processes.[22]

Air pollution monitoring is intermittent in Beirut (three stations run by universities), regular in Tripoli (24 stations run by the federation of municipalities) and self-performed by a number of polluting industries (stack reading for the fertilizer and cement industries). Trends in air pollution volumes appear to be mixed: whilst SO_2 emissions have fallen over the last decade, those for NO_2 and NMVOCs have stayed roughly constant while those of PM_x have risen steadily.

Cities having the most significant air pollution problems tend to be those with the highest population totals and where there are industrial complexes close by. These cities therefore include Beirut and Tripoli. Nevertheless, the industrial cluster of Selaata-Chekka grouping the main fertilizer and cement industries are not included in the analysis below.

Table 3-1 illustrates the number of respiratory cases reported by the Ministry of Public Health (MOPH). The numbers indicate prevalence as per hospital admissions. The hospital admissions apply to 51.7% of the population (2007) who are eligible for MOPH-subsidised treatment, i.e. those who do not have any type of health insurance (e.g., Social security, Army and Police, Civil Servants' COOP, and private insurance). The total number cannot be considered as total prevalence since the admissions are drawn only from the public hospitals' admissions across the country, therefore it is underestimated. The number could also potentially be an overestimate since the socio-economic status of MOPH-admitted patients is likely to differ than that of the total population. Extrapolation to the entire population of Lebanon should thus be carefully done, and the limitations should be clearly spelled out.

22 Andrew Farmer calculations.

Table 3-1 Respiratory disease cases reported by the Ministry of Public Health - Lebanon

ICD10 Code	Diseases of the respiratory system	2006 #	2007 #	2008 #	2009 #
J41	Simple and mucopurulent chronic bonchitis	4	4	9	10
J41.0	Simple chronic bronchitis	—	1	4	2
J41.1	Mucopurulent chronic bronchitis	—	2	1	—
J41.8	Mixed simple and mucopurulent chronic bronchitis	—	1	2	—
J44	Other chronic obstructive pulmonary disease	63	146	185	23
J44.0	Chronic obstructive pulmonary disease with acute lower respiratory infection	15	11	61	38
J44.1	Chronic obstructive pulmonary disease with acute exacerbation, unspecified	20	36	29	33
J44.8	Other specified chronic obstructive pulmonary disease	13	14	35	42
J44.9	Chronic obstructive pulmonary disease, unspecified	129	212	276	281
J45	Asthma	299	429	470	538
J45.0	Predominantly allergic asthma	13	34	49	63
J45.8	Mixed asthma	1	5	1	1
J45.9	Asthma, unspecified	139	146	167	168
J46	Status asthmaticus	61	113	106	115
J47	Bronchiectasis	2	9	9	5

Source: data provided by the Ministry of Public Health (2006-09).

3.2.2 Potential environmental improvements

The 2020 baseline level of emissions for each pollutant is simulated on the basis of the assumption that emissions increase on a linear proportionate basis to the average annual GDP growth rate as adopted across the ENP project, such that a 1% increase in GDP leads to a 1% increase in pollutant emission levels. The average annual GDP growth rate for the Lebanon is 3.75% over the period.

Table 3-2 Air Pollution Emissions: Baselines and Targets – Lebanon, 2020

Compound Baseline/Target	NH_3 Tons	NMVOC Tons	NO_x Tons	$PM_{2.5}$ Tons	PM_{co} Tons	PM_{10} Tons	SO_2 Tons
2008 Baseline	15,809	73,261	76,846	25,005	15,320	40,325	206,146
2020 Baseline	18,016	83,492	87,577	28,497	17,459	45,956	234,934
50% reduction	9,008	41,746	43,788	14,248	8,730	22,978	117,467

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.

There exists no published targets for air quality in Lebanon that simulate WHO limit values or that attempt to replicate the values implied by conformity to EU Air Quality (AQ) Directives, relative to a 2020 baseline. Consequently, to establish targets, we adopt reductions from the 2020 baseline that have typically been required in countries adopting the EU AQ Framework Directive. In the case of air quality, a 50% reduction is assumed to be typical and is utilised. The target is therefore emissions at 50% of their 2020 baseline. The baseline and target data are presented in Table 3-2.

The estimated health benefits of the emission reductions will be expressed in physical and monetary terms. The benefits from reduced crop damage and material soiling are included in the overall estimates of monetary benefits resulting from the emission reductions.

3.2.3 Qualitative assessment of the benefits of reaching the targets

A number of benefits will accrue if the ambient air quality improvement targets are achieved. Informing and involving the public in environmental and health matters not only helps to build trust within communities and between communities and government (and potentially industry), it can also improve social cohesion. In many countries information supply to the public is poor, especially for socially excluded groups. The benefits are illustrated in Box 3-1.

Box 3-1 Benefits associated with air quality improvement	
Health benefits	The health consequences of exposure to air pollution are considerable and span a wide range of severity from respiratory track sensitisation and irritation, coughing and bronchitis to heart disease and lung cancer. Vulnerable groups include infants, the elderly, and those suffering from chronic respiratory conditions including asthma, bronchitis, or emphysema. Many of air pollution's health effects, such as bronchitis, tightness in the chest, and wheezing, are acute, or short term. Other effects appear to be chronic, such as lung cancer and cardiopulmonary diseases. These health effects entail a significant economic cost including the cost to the economy (restricted activity days) and the costs to national health services. Both acute and chronic effects can be reversed if air pollution exposure declines as a result of emission reductions. Lower incidence of acute and chronic disease will ensue from the: – Reductions in SO_2 imply lower incidence of cardiovascular and respiratory disease; – Reductions in PM_{10} and $PM_{2.5}$ concentrations imply lower emergency-room visits due to asthma, and also lower 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, in asthma patients and young children.
Environmental benefits	Ecosystems: Damage to forests, lakes and streams from acidification resulting from SO_2 and NO_x has a major impact on the health of ecosystems and biodiversity in general. In some cases, existing acid deposition may have caused critical loads to be reached in ecosystems and much damage will be irreparable. High concentrations of lead also adversely affect domestic animals, wildlife and aquatic life. More indirectly, the effects of climate change, contributed to by NO_x and SO_2, are as of yet not fully known, but potentially very damaging to global ecosystems. Crop damage: Sulphur dioxide and nitrogen oxides, in their gas form, also contribute to crop damage through the degradation of chlorophyll. Reducing the release of these gases in the atmosphere will bring tangible benefits to agriculture, agro-forestry and fisheries industries. In addition, SO_2 and NO_x are known to corrode building structures at great economic cost. Vegetation: Ozone has an impact on vegetation at concentrations not far above ambient background levels. It can cause damage to natural ecosystems and to crops. The effects of ground-level ozone on long-lived species such as trees are believed to add up over many years so that whole forests or ecosystems can be affected in the long term. For example, ozone can adversely impact ecological functions such as water movement, mineral nutrient cycling, and habitats for various animal and plant species. Ground-level ozone can kill or damage leaves so that they fall off the plants too soon or become spotted or brown. These various impacts will be reduced as a consequence of air pollution emission reductions. Ecosystem condition improvements include:

Box 3-1 Benefits associated with air quality improvement	
	– Reduced acidification from lower SO_2 and NO_x emissions – Reduced climate change impacts from lower SO_2 and NO_x emissions – Reduced damage to vegetation from low level ozone
Economic benefits	A wide range of environmental technologies and new *cleaner* primary inputs, are required to bring about cleaner production processes that will be needed to meet the standards in the EC directives. These industries will benefit economically from increased sales as will society from increased employment in these sectors. There will also be potential benefits derived from improved tourism in areas that were previously damaged by acid rain such as the area surrounding Selaata in the north. *Green technology* industries through the 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. *Green growth and green jobs with incentives provided by the Government.* Increased visits to improved landscapes and natural areas through the increase of Increase in tourism and associated expenditures in local areas. Lower material cleaning costs through the reductions in expenditures on building surfaces soiled by particulates. Reduced crop damage from lower SO_2 and NO_x emissions Crop damage reductions through reduced low-level ozone.
Social benefits	The social benefits of reduced pollution to air are myriad and relate to improvements to the quality of life (e.g. through reduced health effects), the increased amenity value of improved landscapes, nature and air quality, reduced damage to cultural heritage such as historic building surfaces in city centres, and increased commuting and use of clean public transportation. Improved quality of life will ensue: – 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 will ensue 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, mosques, 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.

Source: See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

3.2.4 Quantitative assessment of the benefits of reaching the targets

Health benefits

The pollutants for which quantitative estimates of benefits were possible include: Ammonia (NH_3), Particulate matter (coarse and fine) (PM), Nitrogen Oxides (NO_x), Sulphur Dioxide (SO_2) and Volatile Organic Compounds (NMVOCs).

Table 3-3 Physical premature mortality and morbidity impacts avoided – Lebanon, 2020

Impact	Deaths Avoided #	Morbidity Case Avoided #
Avoided air pollution-related premature mortality and morbidity	376	564

Source: See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

As the MOPH respiratory diseases are under reported, the mortality and morbidity impacts of the pollution emission reductions were based on international exposure-based analysis and are shown in Table 3-3 for 2020 – the year in which it is assumed the 50% reduction from 2008 levels is achieved. The benefits of these reductions in surrounding countries –due to reduction of trans-boundary transport of pollution from Lebanon-- are also given. Morbidity impacts are of a disparate nature and so cannot be expressed as a common unit. However, for illustration, the morbidity impacts are presented in

Table 3-3 as equivalent number of cases of chronic bronchitis avoided.

Economic benefits

In the case of materials, the impact being quantified is the premature ageing of various building materials exposed to SO_2 deposition from acidification. Thus, in our context, the whole exposed material surface area to SO_2 will age at a slower rate than if the emission reductions were not made. The economic benefits are therefore estimated by multiplying the changes in aggregate damage to the surface areas by the cost of cleaning these surface areas.

Crop damage is measured primarily by the change in yield that results from the change in pollutant concentrations in the air. Thus, with knowledge of the geographical distribution of crop plantations within a country, the acreage of a given crop affected by a change in pollutant concentration can be estimated and the percentage yield change can be derived. The modelling then multiplies this aggregate yield change by the market price of the crops. In this case, we did not have sufficient data to make this estimate.

3.2.5 Monetary assessment of the benefits of reaching the targets

The monetary values of the benefits from reduced air pollution - as assumed above - are presented in summary form in Table 3-4. Values presented are in million Euros (2008 prices), and relate to the year 2020, to which the assumed target of a 50% emission reduction applies. Underlying unit values, unadjusted for PPP, are listed in the Benefit Assessment Manual (Bassi et al., 2011).

The benefits are valued at € 800,000 or LP 1.7 billion per avoided fatality and € 16,000 or LP 350 million per avoided case of chronic bronchitis-equivalent. All figures are in 2008 purchasing power parity (PPP) adjusted € and 2008 LP. Table 3-4 shows that the total domestic benefits to Lebanon are equal to € 455 million each year, equivalent to 1% of annual GDP. These domestic benefits are understood as benefits which accrue to Lebanon as a result of its own emission reductions.

Table 3-4 Benefits of meeting air pollution emission reduction targets – Lebanon, 2020

Monetary benefit	**2020 Target** € PPP million	**2020 Target** LP billion	**% of 2020 GDP**
Mortality	319	412.8	0.7
Morbidity	96	124.2	0.2
Crop	27	34.9	0.1
Material	14	18.1	0.03
Total	**455**	**588.9**	**1.0**

Source: See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

Additional sensitivity analysis revealed initial estimates of the possible extent of the total trans-boundary benefits - the benefits outside Lebanon – that may result from the air pollution emission reductions in Lebanon. We found that these benefits may be as much as 1.2 times as high as the domestic benefits, though the specific geographical and social contexts may well mean that the reality differs significantly from these modelled results. These results do, however, serve principally to draw attention to the fact that these trans-boundary effects exist and may be important in assessments of regional air quality strategies.

4 BENEFITS OF IMPROVING WATER RELATED CONDITIONS

4.1 Introduction to water quality issues

Lebanon has potentially sufficient water resources to meet domestic demand at least until 2020, however, poor governance, and water resources, water allocation and water distribution mismanagement characterise the sector. Water abstraction (about 1 billion m^3 per year) is below the theoretical water demand though (estimated at 1.4 billion in 2010) and the increasing water demand driven by demographic growth, tourism and economic activities in the future will put the sector under increased strain as the resource will also be prone to climate change affects. Domestic water supply is below capacity and sometimes below drinking standard prompting consumers to augment (bottled water, wells, etc.) and/or treat their water supply. Surface and groundwater quality is below standards with increased coastal groundwater salinisation and most of the domestic and industrial water is released untreated hence affecting watersheds, one artificial reservoir (Qaraoun) and the coastal zone with a number of direct and indirect effects on health, household spending, yields, production cost, ecosystems, etc. Also, the lack of municipal and industrial waste water treatment capacity exacerbates the degradation of water resources that are also affected by runoffs moderately loaded with nitrates and pesticides. A water-wide strategy was formulated in 2010 but has yet to be endorsed by the Government and ratified by Parliament.[23]

This section covers the following aspects of water quality:

- Man-made infrastructures:
  - Connection to safe drinking water
  - Level of sanitation and hygiene, i.e., connection to the sewage network and hygiene conditions
  - Level of waste water treatment
- Natural assets
  - Surface water quality
  - Water resource use

4.2 Benefits from improved connection to safe drinking water

4.2.1 Current state

With limited investments over the last decade (LP 189 billion between 1999 and 2008) coupled with average cost recovery (70% bill collection efficiency and 8% illegal connection to the network),[24] unreliable water supply continuity and pressure associated with poor water quality is provided by 4 Regional Water Establishments (RWEs): Beirut and Mount Lebanon (BML); Southern Lebanon (SL); Northern Lebanon (NL); and Baalbeck and the Beqaa (BB).

23 MOEW (2010).
24 World Bank (2011); and World Bank (2009).

Water quality

Water quality monitoring remains a challenge as water quality monitoring statistics are unpublished. Two institutions are responsible for domestic water testing: the Ministry of Energy and Water (MOEW) tests the water quality at the meter/gauge level whereas the Ministry of Public Health (MOPH) tests the drinking water at the tap, which produces different results as water supplied by the public network and from private wells or unlicensed trucks are stored in the same containers/reservoirs, which could increase the chances of drinking water cross-contamination, especially during summertime. Poor drinking water quality could possibly be explained by the high reliance on bottled water and water treatment.

Water-borne diseases

A number of water-related disease cases are illustrated in Table 4-1 although these statistics do not reflect the whole picture as they are only reported by the public sector health service. Moreover, the most recent diarrhoea prevalence of 11.2% dates back to 2004. The private sector health service, which is the larger health service provider in Lebanon, does not aggregate health statistics. Therefore, water-related health statistics are underreported in Lebanon. An improvement in sewage collection (in combination with improved hygiene practices) is believed to help reduce these cases of illness. Statistics on hygiene do not exist in Lebanon (timing of hand washing with soap or without soap) but Tripoli and Saida are well known cities for their ancestral production of olive oil based soap making the use of soap a common practice in most households in Lebanon. Hence, it is possible that water-borne diseases are more related to the quality of water than hygiene practices in Lebanon.

Table 4-1 Cases of reported Hepatitis A, Dysentery and Typhoid – Lebanon, 2001 - 2010

Disease	Hepatitis A			Dysentery			Typhoid		
Year	2001	2005	2010	2001	2005	2010	2001	2005	2010
Cases	319	210	188	2,206	147	183	580	461	366

Source: data provided by the Ministry of Public Health (2010).

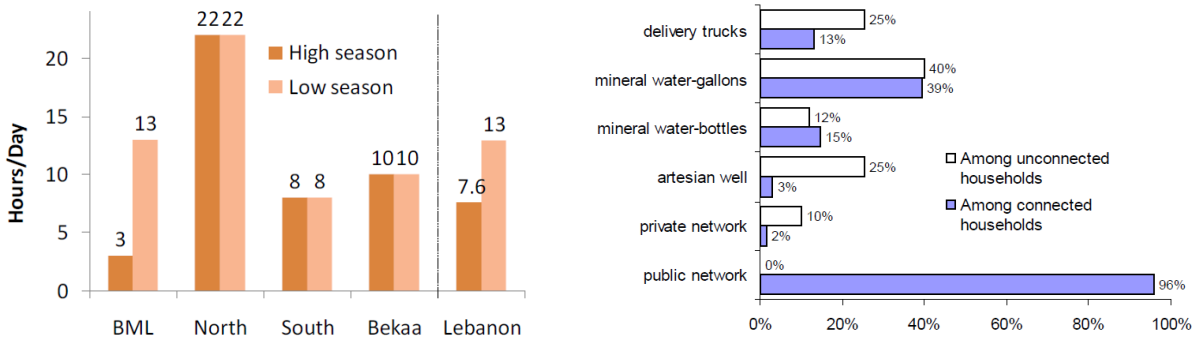
Water regularity and consumption

The RWEs' water supply services cover 79% of the population, however, the provision of water is low and irregular across regions with a seasonal daily supply ranging from 3 hours in Beirut (BML) during summertime to 22 hours in Tripoli (NL) throughout the year (Figure 4-1). Water consumption is yet another conundrum in Lebanon due to the multiplicity of water sources with supposedly one of the highest bottled water consumption rates in the Middle East and North Africa region with the tourism activity also contributing to the high demand of bottled water (Table 4-2). Actual household water consumption is neither monitored nor used to calculate charges. Nevertheless, even those households with meters (10%) still pay fixed charges for 1 m^3 of water per day per household. Hence, the theoretical water consumption through the network is 236 litres per capita per day. Per capita consumption was recently estimated nationally at 149 litres per day with large variations across regions (121 in BML to 197 in NL),[25] however: an on-going GIZ metered water consumption pilot in

25 World Bank (2009).

rural (Hamat in the North) and urban (quarter of Saida in the South) areas suggests a consumption of about 240 (includes water used for small gardens) and 124 litres per capita per day respectively when the water pressure is available 24 hours a day 7 days a week.[26] Interestingly, the consumption in Hamat is almost equal to the theoretical consumption. The results of a recent survey on the multiple alternative water sources are illustrated in 4-1.

Figure 4-1 Household water continuity of supply and consumption by source - Lebanon, 2008



Source: World Bank (2008).

Water and sanitation tariffs and fees

Water tariff rates, which are on average equivalent to € PPP 181.1 based on 1 m^3 per day per household, reflect historical pricing policies and not real cost recovery levels. In most cases tariff rates are insufficient to cover operations and maintenance (O&M) costs, let alone capital investments, and need to be doubled. A recent stated preference survey revealed that only half the respondents were willing to pay more than an additional 21% to the public tariff for better service, while one-third would pay 50% per year more, which shows a lack of trust in the services provided by the RWEs.27 Only BML RWE covers its O&M cost and even some amortization cost unlike the three other RWEs that need to be subsidised.[28] Still, volumetric pricing will be possible in certain areas as the installation of meters is suggested in the 2010 National Water Sector Strategy although current water meter coverage represents only 10% of total water connections of 675,347 with large variations: 2% in BML and 32% in NL.

The sewer fee is levied at the municipal level and covers both solid waste collection and combined drainage-sewerage network O&M. The annual fee is set at 1.5% of the lease assessment and is characterised by a low collection rate that usually covers a fraction of the solid waste collection O&M. The sewer fee was recently estimated at LP 24 billion or € PPP 18.4 million in 2007 with 88% being collected by the BML RWE.[29]

Waste water (treatment) tariff rates are planned to be introduced in 2011 in areas where treatment has started but should not exceed € PPP 42 per household per year to be increased to € PPP 96.7 per household per year by 2015, which is markedly below the

26 Personal Communication with Younes Hassib, GIZ, Lebanon.
27 World Bank (2009).
28 World Bank (2009).
29 World Bank (2011).

suggested GIZ calculation to cover O&M and investment cost: € PPP 53 and € PPP 268 per household per year respectively.[30]

The Polluter Pays Principle was introduced in the Environment Framework Law (444/2002) but it lacks application decrees.

Actual water and waste water tariffs are within the 3% to 5% range of household income suggested by the World Bank and even the doubling of water tariffs (let alone using a volumetric tariff with a social tariff when the meter coverage will be implemented) and waste water tariffs will remain within the affordability margin although the trust issues remain an important matter to be resolved before the gradual increase or introduction of new tariffs by linking a positive consumer service satisfaction feedback with a gradual tariff increase.

Access to drinking water and sanitation

Lebanon has a very high level of improved drinking water (95%) and sanitation (98%) coverage.[31]

Table 4-2 Access to drinking water and sanitation facilities - Lebanon, 2008

Drinking water	**Urban**	**Rural**	**Total**
Piped water on premises	100%	NA	80%
Other improved water sources	0%	NA	15%
Unimproved water sources	0%	0%	5%
Sanitation			
Toilet connected to sewage network			66%
Other improved sanitation			32%
Unimproved sanitation*	NA	NA	2%
of which: Open defecation	*NA*	*NA*	*0%*

Note: including toilet facilities shared by households.*
Source: CAS/MOSA (2008); and WHO/UNICEF (2010a).

Access to drinking water is as follows (Table 4-2):

- About 80% of the population has piped water supply on premises.
- About 15% uses other improved drinking-water sources.
- About 5% uses unimproved drinking-water sources.

Access to sanitation is as follows (Table 4-2):

- Over 66% of the population has flush/pour flush toilets connected to a sewage network system.
- About 32% has access to other improved toilet facilities.
- About 2% of the population relies on unimproved sanitation.

30 MOEW (2010); and Hassib (2008).
31 CAS/MOSA (2008).

Population coverage of piped water supply is somewhat higher in urban than in rural areas. Data have not been collected on urban and rural sewage connection.

Addressing domestic improvement of water, sanitation and hygiene

Given the state of drinking water, the BA will address the 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.

Box 4-1 Definitions of key terms used

- *Reliable piped water supply*: Continuous and plentiful water supply delivered at appropriate and constant pressure to household premises (yard/dwelling) through a piped water distribution network from a central water intake.
- *Safe drinking water*: Drinking water that does not contain biological, chemical or other agents at concentrations or levels considered detrimental to health according to WHO guidelines for drinking water quality.
- *Plentiful water*: The amount of water needed to satisfy metabolic, hygienic and domestic requirements. This is usually defined as a minimum of 20 litres of water per person per day (see DESA, 2007).
- *Improved water sources*: Piped water to premises (dwelling/yard); public standpipes; tubewells/boreholes; protected dug wells and springs; and use of rainwater.
- *Unimproved water sources*: Unprotected dug wells and springs; tanker trucks/vendors; and open surface water sources (rivers, ponds, etc.).
- *Sanitation*: Here defined as systems, facilities, and practices for disposal and removal of human excreta (urine and faeces). Sanitation systems include sewage networks, septic tanks and pits, and waste water treatment. Sanitation facilities include various types of toilets, and sanitation practices include practices such as open defecation.
- *Improved sanitation*: Flush/pour-flush toilets to sewage networks, septic tanks or pits; ventilated improved pit toilets (VIP); and pit toilets with slab.
- *Unimproved sanitation*: Pit toilets without slab; hanging toilets over water; bucket toilets; and open defecation (no access to a toilet facility). Households sharing toilets with other households are also classified as having unimproved sanitation, regardless of type of toilet.
- *Sewage*: Waste water from households (and industry and other sectors) which is collected and carried off in a sewage network. Sewage generally contains human excreta and water and may also contain other wastes (e.g. kitchen waste).
- *Sewage network*: A closed system of sewage pipes used to carry off sewage and drainage water. Improved toilets connected to a sewage network are classified as improved sanitation and is often considered as the most developed stage on the sanitation ladder.
- *Hygiene*: A procedure or system of procedures or activities used to reduce microbial contamination on environmental sites and surfaces and the external body in order to prevent the transmission of infectious disease (see IFH, 2001).

Source: See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

Benefits of improved waste water treatment and improved surface water quality are assessed in other sections.

A set of targets for the achievement of the three water, waste water and hygiene parameters by 2020 are specified and improvements resulting from reaching the targets are

estimated at the national level as benefits of these improvements are discussed qualitatively, and some of the benefits are quantitatively assessed. The quantitative assessment of the three parameters is undertaken jointly as many households will benefit from improvement in more than one parameter (Box 4-1).

Piped water supply to premises (yard/dwelling) and connection to a sewage network are seen in most countries as the best opportunity to provide households with reliable and safe drinking water and ensure safe and hygienic removal of human excreta and other waste water 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 source water is generally of good quality and the piped distribution networks are well functioning, such a water supply system has the potential to provide safe drinking water with minimal risk of disease.

Connection to a sewage network provides the added opportunity of minimizing pollution of water and land resources through central treatment of waste water.

Good hygiene practices are also of utmost important 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%.[32]

4.2.2 Potential environmental improvements

2020 Baseline

To estimate the number of beneficiaries and benefits of achieving the targets, the targets are compared to the percentage of the population currently 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% is applied. Other baseline data are presented in Table 4-3.

Table 4-3 Baseline assumptions - Lebanon, 2020

Baseline	2008 (actual or estimated)	2020 (projected or business-as-usual)
Population (million)	4.19	4.58
Birth rate (births per 1000 population)	15.7	14.9
Mortality rate from diarrhoea among children < 5 years (deaths per 1000 live births)	0.3	0.3
Mortality rate from other infectious diseases among children < 5 years (deaths per 1000 live births)	2.6	2.3
Diarrhoea (cases/year, children < 5 years)	2.3	2.3
Diarrhoea (cases/year, population >= 5 years)	0.45	0.45
Household size	4.2	4.2

32 Curtis and Cairncross (2003); and Fewtrell et al. (2005).

Source: PAPFAM (2004); CAS/MOSA (2008); World Bank (2010); and WHO (2010).

These data represent projections or a business-as-usual scenario if no water, sanitation and hygiene interventions are undertaken to reach the targets.

Baseline assumptions:

- Birth rates are projected to decline by 5%.
- 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 1% per year.
- Average household size is assumed constant over the period to 2020.

2020 Target

Targets for which benefits are assessed are:

1. Drinking-water:
   a) Achieving 100% population connection (except in isolated rural areas) to reliable and safe piped water supply at household premises.
   b) Ensuring that the population currently having piped water supply continuously receives reliable and safe water at household premises.
   c) Providing plentiful and equally safe drinking water from other improved water sources in isolated rural areas.
2. Sewage connection:
   a) Achieving 100% population connection (except in isolated rural areas) to a sewage network system.
   b) Upgrading to flush toilet (with sewage connection) for households with dry toilet or no toilet).
   c) Providing improved sanitation to households currently without such facilities in isolated rural areas.
3. 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 a piped water supply and connection to a sewage network have many advantages, these systems are, however, not necessarily free from problems. Piped water can get 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.

Status of hygiene practices is generally not available in most countries unless detailed studies/surveys have been undertaken. Yet, substantial improvements in hygiene practices can be achieved in most countries in the world. As status of hygiene practices is not well known in Lebanon, the assessment in this study provides a benefit range of achieving the targets that at the lower end reflects an assumption that hygiene practices are generally adequate for protection of health and at the higher end reflects an assumption that practices can be substantially improved. In reality, benefits may be expected to be somewhere in between these two values.

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.

Table 4-4 Number of beneficiaries from reaching the targets - Lebanon, 2020

Intervention	**Number of people** million	**Number of households** million
Reliable and safe piped water supply to premises	0.9	0.2
Improvement in reliability and quality of water among those currently with piped water supply	0-3.7	0-0.9
Connection to sewage network (treatment is covered under Section 0)	1.6	0.37
Improved hygiene practices	0-4.6	0-1.1

Source: See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

Improvements include:

- An additional 0.9 million people or 0.2 million households would have reliable and safe piped water to premises, and an additional 1.6 million people or 0.36 million households would have connection to a sewage network system (Table 4-4).
- As some rural communities may be too isolated to be provided these services, 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 - 4.6 million people or 0 - 1.1 million households.

4.2.3 Qualitative assessment of the benefits of reaching the targets

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. A generic overview of these benefits is provided in Box 4-2. Some of

these benefits (environmental, recreational, improved water resources) are discussed in the sections on Waste Water Treatment, Surface Water Quality, and Water Scarcity.

Many of the benefits of reliable and safe piped water supply and connection to a sewage network are difficult to quantify. An indication of some of the economic benefits of improving reliability and safety of piped water supply is that about 31% of the population currently purchases bottled water for drinking and 11% treat their water prior to drinking.[33] Provision of reliable and safe piped water would reduce the need for such purchases and household water treatment.

Box 4-2 Benefits of improved potable water supply, sanitation and hygiene practices

Benefits	**Good quality piped water supply**	**Connection to a sewage network system (and flush toilet for those with dry toilet or no toilet)**
Health benefits	– 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.	
Environmental benefits	– 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 quality of raw water abstraction sources.	Sewage collection provides opportunity for proper treatment of waste water 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 Waste water Treatment and Surface Water Quality).
Economic benefits	– Piped water connection with reliable and continuous good quality water reduces/ eliminates the need for: o household water storage tanks o 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: o reduces public and private health care expenditure o improves labour productivity and reduces work absenteeism. – Access to good quality water can also	– The environmental benefits (see above) of sewage collection and proper treatment of waste water can provide substantial recreational, tourism, and fishery benefits. – Good treatment of waste water can also: o allow for waste water reuse in agriculture o provide substantial cost savings in mobilizing and treating potable water, especially important in water scarce countries (see section on Water Scarcity).

33 World Bank (2009).

Box 4-2 Benefits of improved potable water supply, sanitation and hygiene practices		
Benefits	**Good quality piped water supply**	**Connection to a sewage network system (and flush toilet for those with dry toilet or no toilet)**
	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.	
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) o increases household convenience (no needs for emptying and maintaining sewage pits/septic tanks; reduced access time to toilet facility or place of defecation), and o reduces odours and nuisance from preventing direct sewage discharge into the local environment.

Source: See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

4.2.4 Quantitative assessment of the benefits of reaching the targets

Expected reduction in annual incidence of diarrheal disease and diarrheal mortality from reaching the targets is presented in Table 4-5 by population groups in relation to their current status of water supply, sanitation (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.[34]

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.

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

34 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.

on average for these population groups from improvement in reliability and quality 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%.[35]

Table 4-5 Diarrheal morbidity and mortality reduction from reaching targets - Lebanon

Groups	Current water supply and sanitation coverage	Population distribution 2008	Water and sanitation improvement	Expected average reduction in diarrheal disease and mortality	
				Already good hygiene	Substantial scope for hygiene improvement
1	Piped water supply and sewage connection	66%	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	15%	45%
2	Piped water supply but no sewage connection	14%	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.	35%	65%
3	Not piped water supply but sewage connection	0%	Reliable and safe piped water supply to premises for all of this population	25%	55%
4	Not piped water supply and no sewage connection	20%	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	45%	75%
National total		**100%**		**26%**	**58%**

Note: Population distribution estimated from WHO/UNICEF (2010a,b).
Source: CAS/MOSA (2008); WHO/UNICEF (2010a,b); See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

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 26% if the entire population has good hygiene practices adequate for health protection, and 58% if hygiene practices can generally be substantially improved. In actuality, disease and mortality

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

reduction likely falls somewhere in between these two values, depending on current hygiene practices.

4.2.5 Monetary assessment of the benefits of reaching the targets

The annual benefits in year 2020 of achieving the targets amounts to 0.7-1.6 million avoided cases of diarrhoea and 11-24 avoided deaths (Table 4-6). The value to society of these benefits is estimated at € PPP 76-169 million or LP 99-219 billion, equivalent to about 0.16-0.36% of 2020 GDP. The benefits are valued at € PPP 800,000 or LP 1.0 billion per death and € PPP 94 or LP 121,600 per case of diarrhoea.

Table 4-6 Benefits of meeting the water, sanitation and hygiene targets – Lebanon, 2020

Burden of Disease			**Annual cases avoided**	
			Low	High
Diarrhoea			718,260	1,597,592
Deaths			11	24
Monetary benefit	**2020 Target**			
	€ PPP million		LP billion	
	Low	High	Low	High
Morbidity	67	150	87.3	194.2
Mortality	9	19	11.3	25.2
Total	**76**	**169**	**98.7**	**219.4**
% of 2020 GDP	**0.3%**		**0.3%**	

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.
Source: See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

4.3 Benefits from improved domestic waste water treatment

Introduction to domestic waste water treatment issues

Domestic waste water is one of the most important pollution sources of water courses and marine waters in Lebanon due to its contamination by biological and chemical pollutants. Nevertheless, the waste water sector is in its infancy in Lebanon and the lack of treatment is degrading the water quality of river basins, the Qaraoun (220 million m^3 capacity) and to a lesser extent Shabrouh (15 million m^3 although it exists up in the mountains with an upstream pristine area) reservoirs and coastal marine ecosystems. The 2010 National Water Sector Strategy aims to speed up investment spending over the next 4 years to substantially increase the network coverage and treatment capacity by 2020.[36]

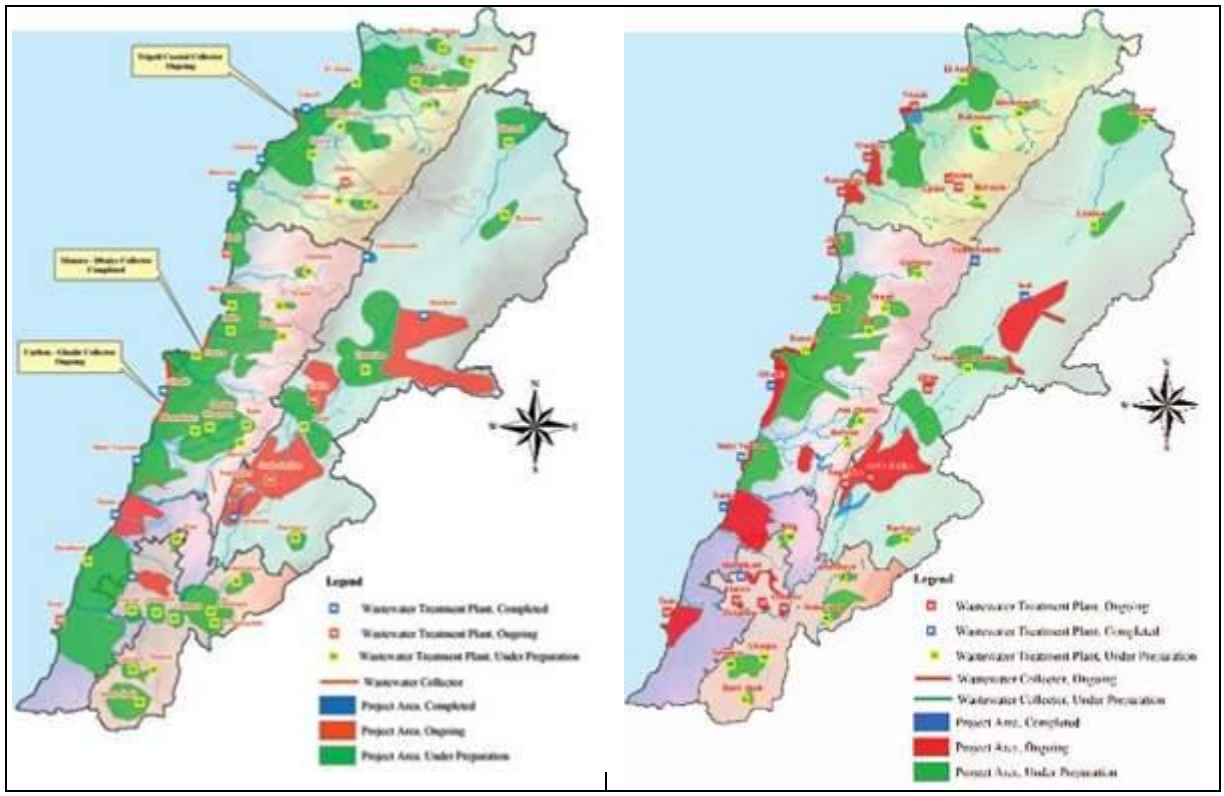
4.3.1 Current state

Domestic waste water sources

36 CAS/MOSA (2008); and MOEW (2010).

The per capita discharge rate is estimated to be about 150 litres per day in BML and 100 litres per day in SL, NL and BB, leading to a total waste water generation of 259.4 million m^3 per year based on a 4.2 million population (Table 4-7).[37] The largest portion of the waste water generation is discharged into sewage networks (67%), while the remaining is discharged into septic tanks, open drains or in nature.

Figure 4-2 CDR's 52 and 28 priority waste water treatment plant status - Lebanon, 2010



Source: CDR (2010).

The Council for Reconstruction and Development (executing arm of the Government of Lebanon) has 52 waste water treatment plants (WWPTs) in the pipeline (12 considered, 21 under preparation, 12 under construction and 7 completed) of which about 28 WWTPs are considered a priority with a design capacity of 360 million m^3 per year, and which are already constructed, under construction or planned (Figure 4-2). To date, there are about 11 operating WWTPs (4 in BML, 2 in SL, 1 in NL and 4 in BB) and 6 constructed major WWTPs (Tripoli, Chekka, Batroun, Jbeil, Ras Nabi Younes and Nabatiyeh) of which 5 along the coast that are not yet connected to the network.

When only considering the operating WWTPs, 19.1% of the 710,538 m^3 per day of domestic waste water generated in 2008 is considered to be pre-treated or treated to secondary levels removing 5.9% of the BOD_5. Hence, 80.9% of municipal discharge remains untreated. In terms of the population living in settlements with more than 2,000 people, the population whose municipal discharges are subject to any kind of treatment reach 513,370 people or 14% with pre-treatment constituting the larger share.

37 A 1.34 coefficient set by CDR is applied to determine the population equivalent. World Bank (2011).

Table 4-7 Waste water discharge and treatment – Lebanon, 2008

Indicator	Total	Primary treatment (Mechanical treatment plants)			Secondary treatment	Tertiary treatment (if any)
		Sea outfall	Inland water outfall	Total		
Total waste water discharged (m^3/day) pop. equivalent	710,538					
# inhabitants connected to WWT plants	513,370	319,430	0	319,430	193,940	0
Total population*	3,564,694					
% connected over population	14.4	9.0	0	9.0	5.4	0
Waste water treated (m^3/day) pop. equivalent	135,695	109,930	0	109,930	25,765	0
% treated over total waste water discharged	19.1	15.5	0	15.5	3.6	0
# WWT plants	11	2	0	2	9	0
WWT plants total actual capacity (m^3/day) pop. equiv.	232,055	105,205	0	105,205	126,850	0
WWT plants total design capacity m^3/day) pop. equiv.	232,055	105,205	0	105,205	126,850	0
PE treated (see above)						
PE total capacity (see above)						

*Note: * 85% of the population lives in settlements > 2,000 people.*
Source: World Bank (2010); and World Bank (2011).

Other waste water sources

Contaminated industrial effluents remain a serious problem in Lebanon as they are discharged without pre-treatment to the public sewer network (rainfall drain and municipal/industrial discharge) and were estimated at 43 million m^3 in 2001.[38] High levels of heavy metals, toxic substances, (arsenic, lead, zinc, chromium) and waste oils were found in the waters near seven industrial sites in 2000. The highest levels were found near the Dora industrial area north of Beirut, due mainly to the significant tannery industry located there. Samples of water taken near sewage outfalls all along the coast were found to have high levels of Biological Oxygen Demand (BOD).[39] The Qaraoun reservoir is also the recipient of Zahleh industrial zone effluents in the Beqaa Valley. A number of donors have initiated programs to deal with industrial effluent problems in Qaraoun, Dora and Choueifat (south of Beirut) areas (GIZ and World Bank).

4.3.2 Potential environmental improvements

2020 Target

For the purpose of the assessment of environmental improvements, in this report we only focus on domestic waste water for the sake of simplicity. This does not imply of course that

38 NEAP (draft 2006).
39 MOE (2011b).

the treatment of industrial and other waste water will not have significant benefits. The estimate will therefore necessarily be an underestimate.

The starting point of the analysis is the level of treatment at the reference point, i.e., 2008. The amount of waste water generated is 710,538 million m^3 per year of which 109,930 million m^3 per year get primary treatment and 25,765 million m^3 get secondary treatment; and the balance is either released into septic tanks or in nature, rivers, and the marine environment. This suggests that the share of connection and treatment in 2008 was about 19.1% of total domestic waste water produced.

The estimated baseline level in 2020 assumes that the share of primary, secondary and tertiary treatment will remain constant if no new policy is adopted. This was compared to a target where 100% of at least secondary treatment in urban areas and main rural areas was achieved. The overall improvements are illustrated in Table 4-8 and Table 4-9.

Table 4-8 Improvement in terms of volume treated – Lebanon, 2020

Pop increase rate	Estimated total volume WW in 2020	Estimated volume under primary treat in 2020	Estimated volume under secondary treat in 2020	Estimated volume under tertiary treat in 2020	Estimated volume untreated in 2020	Target	Environmental improvement = target - secondary - tertiary [2020 values]		Env. improvement [2008 values]
%	m^3	m^3	m^3	m^3	m^3	100% at least secondary	m^3	%	m^3
8.7	772,575	119,528	28,014	0	625,033	772,575	744,561	96.4	684,773

Source: See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); Authors.

Table 4-9 Improvement in terms of population with treatment – Lebanon, 2020

Population [2020]	Population increase rate	Estimated population connected to primary treat in 2020	Estimated population connected to secondary treat in 2020	Estimated population connected to tertiary treat in 2020	Target	Environmental improvement = target - secondary - tertiary [2020 values]		Environmental improvement [2008 values]
# million	%	#	#	#	100% at least secondary	#	%	#
3.9	8.7	347,320	210,873	0	3,875,930	3,665,057	94.6	3,370,754

Source: See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); Authors.

In 2020 the environmental improvement would therefore correspond to about an additional 744,561 m^3 of waste water receiving at least secondary treatment. This will imply that about 3.7 million additional people will be connected to at least secondary treatment, i.e., about 80% of the estimated total population in 2020.

4.3.3 Qualitative assessment of the benefits of reaching the targets

Benefits associated with waste water treatment improvement are illustrated in Box 4-3.

Box 4-3 Benefits associated with waste water treatment improvement	
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 diarrhoeal diseases, dysentery, etc.). These benefits are therefore assessed under section 4.2 on sewage connection to avoid duplication. Health problems associated with bathing water are covered under surface water.
Environmental benefits	Most rivers and the urbanized coastal sea bound are polluted notably with coliforms emanating for the lack of waste water treatment and poor management of septic tanks, which affect the direct non-consumptive and consumptive use as well as the indirect use of water resources: underground water as well as domestic and irrigation water abstraction from 17 perennial rivers and through more than 4,000 wells that will significantly benefit from the increase in and improvement of waste water treatment in the future and will lead to a reduction in nutrient discharges and, therefore, to a reduction of damages to aquatic ecosystems, with due improvements to the ecosystems and associated recovery of fish and other aquatic life.
Economic benefits	A number of benefits will accrue following the increase and improvement of the waste water treatment that could or could not be monetised notably: the reduction of the direct and indirect degradation of the marine environment stemming from the non-waste water treatment was equivalent to € PPP 58 million as calculated by the World Bank 2005 COED in 2008 prices; the private sector participation will grow as it will be implicated in the construction of treatment plants and managing them, with a net job creation; the water treatment and possibly pumping cost will be reduced; tourism and recreation along watersheds and the coast will be boosted and will generate more income; the risk of cross contamination of irrigated areas with untreated waste water will be reduced notably in the Beqaa Valley, e.g., Hepatitis A, E, F, etc.; healthier ecosystems will accrue from the treatment; etc.
Social benefits	Most benefits are related to sewage collection, rather than treatment per se, such as nuisance related to notably odours, sight pollution from direct discharge of sewage in the environment, etc. These benefits are therefore assessed under section 4.2 on sewage connection to avoid duplication.

Source: See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); Authors.

4.3.4 Quantitative assessment of the benefits of reaching the targets

The benefits from improved surface water accrue jointly from improved sewer connection and sanitation (septic tanks properly managed) and waste water treatment. The joint assessment is done under sections 4.2 and 4.4. No additional information was available on quantified benefits.

4.3.5 Monetary assessment of the benefits of reaching the targets

The benefits from improved waste water treatment accrue jointly with improved sanitation and surface water. The joint assessment is done under sections 4.2 and 4.4.

4.4 Benefits from improving surface water quality

4.4.1 Current state

Lebanon has 17 perennial and 23 seasonal rivers and the total annual river flow is about 3,900 million m^3. The total perennial river length is 731 km within Lebanon with the Litani

River being the longest with 170 km (Table 4-10 and Figure 4-2). Although not regularly monitored, most physical and chemical variables of perennial rivers are to a large extent within WHO guidelines unlike coliform levels that are unacceptably high indicating pollution from untreated sewage although heavy metals are occasionally found in certain riverbeds mainly closer to coastal and Zahleh's industrial zones. The most polluted rivers in most categories are the Abu Ali, Antelias and Litani. With the exception of bacterial and phosphate loadings, Awali River discharges the highest amount of pollution to the Mediterranean mainly due to its high water flow, although it has one of the lowest pollutant concentrations (Regarding water storage, Lebanon has five lakes and reservoirs, two of which are under construction. The natural lake in Yammouneh (Beqaa) has however almost disappeared. The man-made Qaraoun reservoir (Beqaa with an area of 12.3 km2) is fed from the upper Litani, whose water and sediments are contaminated with bacteriological, chemical and physical compounds. The artificial Shabrouh reservoir (located at 1,555 meters in Mount Lebanon covering an area of about 47,000 m2) is in good condition. Lebanon has failed to build dams to improve water resource management to mitigate the irregularity of the flows especially during the dry seasons. Yet, the ambitious 2010 National Water Sector Strategy calls for the building of 27 dams, which are meant to improve water supply management, including 16 priority dams with a total capacity of 640 million m3. So far, the delays in building dams have ensured the variability of flow of rivers, which help aquatic ecosystems that rely on the natural variability of river flows throughout the year.

Table 4-11).[40] Low levels of pesticides and nitrates are found in surface water but are region specific.[41]

Table 4-10 Perennial rivers - Lebanon

River	Length km	Annual Volume Million m^3	Average Flow m^3/s	Maximum Flow m^3/s	Minimum Flow m^3/s
El Kabir	58	190	6.02	13.9	1.8
Ostuene	44	65	2.07	4.01	0.8
Aaraqa	27	59	2.06	6.27	0.8
El Bared	24	282	8.94	15.2	2.7
Abou Ali	45	262	15.17	37.3	1.6
El Jaouz	38	76	2.40	6.18	0.4
Ibrahim	30	508	16.1	27.6	1.9
El Kalb	38	254	8.04	18.1	2.4
Beirut	42	101	2.59	10	0.1
Damour	38	307	13.8	32.7	0.6
El Awali	48	299	9.71	26.2	3.9
Saitani	22	14	0.73	1.3	0
El Zahrani	25	38	1.59	3.4	0.3
Abou Assouad	15	11	0.35	NA	NA
Litani	170	793	12.5	30.8	4.3
El Aassi (Orontes)	46	480	16.4	20.9	11.5
Hasbani	21	151	4.8	11.3	1.6
Total	**731**	**3,890**	**123**	**265**	**35**

Source: MOE (2011b).

40 Hassan et al. (2007).
41 METAP (2009b).

Regarding water storage, Lebanon has five lakes and reservoirs, two of which are under construction. The natural lake in Yammouneh (Beqaa) has however almost disappeared. The man-made Qaraoun reservoir (Beqaa with an area of 12.3 km^2) is fed from the upper Litani, whose water and sediments are contaminated with bacteriological, chemical and physical compounds. The artificial Shabrouh reservoir (located at 1,555 meters in Mount Lebanon covering an area of about 47,000 m^2) is in good condition. Lebanon has failed to build dams to improve water resource management to mitigate the irregularity of the flows especially during the dry seasons. Yet, the ambitious 2010 National Water Sector Strategy calls for the building of 27 dams, which are meant to improve water supply management, including 16 priority dams with a total capacity of 640 million m^3. So far, the delays in building dams have ensured the variability of flow of rivers, which help aquatic ecosystems that rely on the natural variability of river flows throughout the year.[42]

Table 4-11 Quality parameters for selected rivers - Lebanon

River	BOD_5 mg/l		NO_3 mg/l		TDS mg/l		SO_3 mg/l		Total Coliform c/100ml	E. Coli c/100ml
	2001	2007	2001	2007	2001*	2007	2001*	2007	2007	2007
Litani	79		1.7							
Ibrahim	2.2	62.8	1.1	1		150		8	3,500	200
Kabir	4.1	14.4	3.3	3		270		20	900	20
Kalb	26.3		1.1							
Jaouz	6.6		1.9							
Damour	1.4	21.3	3	3		200		38	490	15
Bared	4.7	28.2	1.4	2.8		225		28	610	17
Awali	3.7	33.4	1.5	7		210		22	710	1
Abou Ali	69.7	39.3	7.3	3.4		280		22	26,500	3,000
Qasmieh		22.5		5.5		250		21	80	0
Antelias		53.2		3		300		30	28,000	6,000

Source: MOE (2011b).

The National Council for Scientific Research operates 21 sea water monitoring stations along the Lebanese coast (230 km) where 8 areas seem highly polluted in Jounieh, Beirut, Saida and Tyre; 7 areas have moderate levels of pollution with the rest seeming to have good coastal water quality (Figure 4-3).

Selectively, 12 water monitoring stations off the Selaata LCC effluent outfall showed excessive parameter levels ranging for acidity between pH 6.3 and 8.3, for high dissolved oxygen saturation between 81.8 and 110.7%, for nitrate 0.02 and 25.4 µg/dl, for phosphate between 0.01 and 54.7 µg/dl and for chlorophyll-a 0.01 and 2.5 mg/m^{-3} over the 2001-02 periods.[43]

Coastal water sampling found elevated cadmium readings in Tripoli (1.89 µg/litre due mainly to the soap and perfumery industries), and Chekka (1.83 µg/litre due mainly to the cement

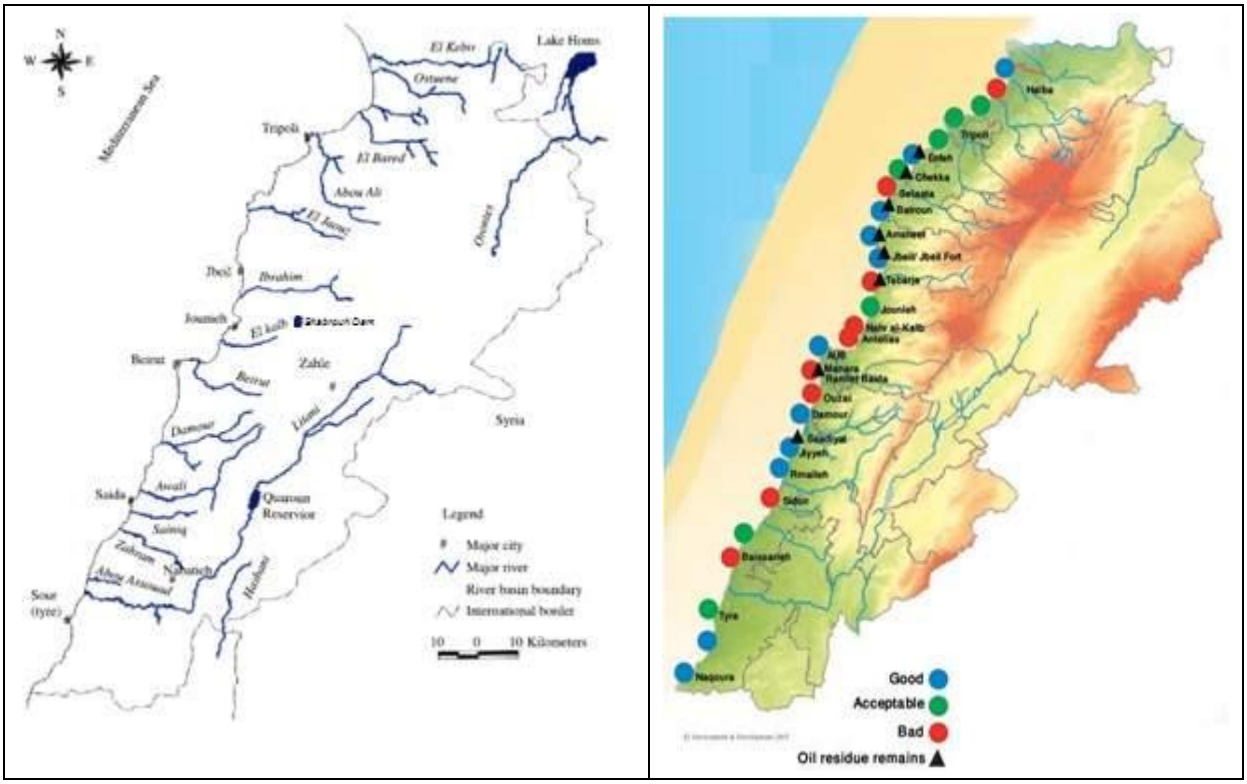
42 MOEW (2010); and MOE (2011b).
43 Fakhri et al. (2005).

and food industries) and average readings in Selaata (0.52 µg/litre due mainly to the fertilizer industry) in 1994[44] that seem under-reported based on more recent studies.[45]

Results from the fishing port of El Mina in 2003 showed elevated levels of BOD and COD due to waste water effluents until 2009 as an outfall was laid down and landfill leachates whilst most heavy metal samples were below local or international thresholds.[46]

Water testing in Tripoli and Batroun revealed that so far, there is in principle no risk of substantial eutrophication from phosphates and nitrates from samples collected.[47] Sea water, fresh water, sediments, and crab sample testing revealed antimicrobial resistant bacterial strains of *Escherichia coli, Salmonella*, *Streptococcus Pneumoniae, Staphylococcus aureus* and *saprophyticus* off the coastline notably of Tripoli and Bebnine, whose origin is seemingly livestock contamination of river surface water that ends up in marine environments.[48]

Figure 4-3 Perennial rivers and coastal pollution – Lebanon



Source: Houri et al. (2007); and Environment and Development (2007).

Bathing water sampling (10 samples along the Lebanese shore and offshore (0.5 to 1 km from the coastline)) revealed high reproducibility of *Coliform count*, *Staphylococcus aureus*

44 Kortbaoui (1997).
45 Nakhle (2003).
46 El-Fadel and Harakeh (2004).
47 Abi Saab et al. (2008).
48 Harakeh et al. (2006a); Harakeh et al. (2006b); and Harakeh et al. (2006).

and *Clostridium perfringens* with non-significant difference between the shore and offshore samplings.[49]

The phosphorous concentrations along the El Kabir River are extremely high throughout the watershed, as were the ammonia-nitrogen and nitrate-nitrogen concentrations, indicating extensive pollution.[50]

After the Jyieh Oil spill that resulted from the 2006 War with Israel, the clean-up is still on-going along the northern coast with bio-indicators revealing that heavy metals emanating from the spill are still being detected in molluscs and crustaceans.[51]

Lebanon coastal tourism infrastructure includes 54 hotels, 97 furnished apartment complexes, 68 beach resorts, 6 public beaches as well as a number of chalets and restaurants.[52] Nevertheless, sea pollution has forced the coastal tourism industry to usually complement sea bathing options with pool bathing options as most hotels and resorts have at least a pool. The direct and indirect marine degradation was calculated in the 2005 COED but the coastal industry runs at full capacity during summertime despite the various levels of water pollution along the coast.

Surface water indicators used in the analysis are recapped in Table 4-12.

Table 4-12 Surface Water Indicators

Number of rivers: 17 perennial and 23 seasonal
Total river length: 731 km for the perennial rivers
Quality of the rivers and estuaries: up to 70% of all natural sources are affected by bacterial contamination and most perennial and seasonal rivers are contaminated with bacterial contamination and occasionally with heavy metals, pesticides and nitrates.
All rivers are considered to be polluted in Lebanon.
Number of lakes: 1 natural about to disappear (due to excessive abstraction through wells in the region) and 2 artificial (220 and 15 million m^3); 2 are under construction.
There is no surface water classification in Lebanon as most surface water is contaminated with waste water, so is the coastal zone (see Figure 4.2).
For the water classification: all 17 perennial and 23 seasonal rivers are considered bad; Yammouneh Lake dried up, Qaraoun is bad and Shabrouh Lake is good. 11 coastal water bodies are considered *good*, 7 *moderate* and 9 *bad*.

Source: CAS website <www.cas.gov.lb>; MOE (2011b); MOEW (2010); See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

Traditional fisheries exist along the coast in Lebanon and catch is being monitored for the northern coast since 2005 at the University of Balamand with the help of FAO. Nevertheless, the marine trophic index[53] 1950-2004 for Lebanon (+0.0044) is higher than the Mediterranean average (+0.0007) which could be interpreted in terms of: overfishing and/or marine pollution affecting the fish catch as the sector has been neglected since the Civil War.

49 Barbour et al. (2004).
50 Hassan et al. (2005).
51 Exchange with Gaby Khalaf, Director, NCSR Marine Research Center.
52 Ministry of Tourism website: <www.destinationlebanon.gov.lb>.
53 Sea Around Us website: <www.seaaroundus.org>

Lebanon is a signatory of the 1973/78 IMO MARPOL International Convention for the Prevention of Pollution from Ships and the 1976/1995 UNEP Barcelona Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean, which aim to prevent sea-based and land-based pollution. Beirut and Tripoli ports, which are the major ports in Lebanon, have reception facilities for collecting ship-generated wastes. However, there is no control on dumping from ships in Lebanon's Economic Exclusive Zone.

4.4.2 Potential environmental improvements

There are a total of 17 perennial rivers in Lebanon with a total length of 731 km. All rivers in Lebanon suffer to varying degrees from the effects of solid waste littering and waste water discharge and are considered polluted. Hence, 60 to 70% of all sampled water sources in Lebanon are subject to bacterial contamination. There are only three lakes in the country, Qaraoun (artificial with a capacity of 220 million m^3 and effective capacity of 160 million m^3) has concentrations of ammonia that are comparable to untreated waste water, Shabrouh (a relatively recent reservoir in a karstic geological area in the upper mountains with 15 million m^3 capacity) and Yammouneh (natural lake) is currently mostly drained. Under the MOEW 10 year plan, 16 additional dams are in the pipeline with a storage capacity of about 800 million m^3.[54]

The water quality parameter employed in this valuation exercise measures the water quality of rivers, lakes, reservoirs, transitional and coastal waters (up to three nautical miles) in Lebanon (see Annex I for the benefit transfer methodology used).

The assessment of the health, social, environmental and economic benefits to society is 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 monetarily, through an economic valuation of the benefits. As for the quantitative assessment of the benefits of improving surface water quality, it is included in the monetary estimation. The aim of the economic valuation exercise is to estimate the total economic value (TEV) of all possible 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 given policy target consists of an improvement from current conditions to the EC Water Framework Directive (WFD) target of "Good Ecological Status" (GES). The approach followed to value improvements in surface water, is the following: values of a UK study that has determined the willingness to pay of households for cleaner water have been adapted for and transferred to Lebanon (Annex I).

The WFD defines which biological elements must be taken into account when assessing ecological status of a water body and distinguishes five status classes: high, good, moderate, poor and bad. 'High status' is defined as the biological, chemical and morphological conditions associated with no or very low human pressure. This is also called the 'reference condition' as it is the best status achievable - the benchmark. These reference conditions are type-specific, so they are different for different types of rivers, lakes or coastal waters so as to take into account the broad diversity of ecological regions in Europe. Assessment of

54 MOEW (2010).

quality is based on the extent of deviation from these reference conditions, following the definitions in the Directive. 'Good status' means 'slight' deviation, 'moderate status' means 'moderate' deviation, and so on.

Good ecological status is defined in the WFD, in terms of the quality of the biological community, the hydrological characteristics and the chemical characteristics of a water body. Because of geographical and ecological variability, GES has been generally described as that water quality condition which represents only a slight departure from the biological community which would be expected in conditions of minimal anthropogenic impact.

The practical definition of ecological status takes into account specific aspects of the biological quality elements, for example "composition and abundance of aquatic flora" or "composition, abundance and age structure of fish fauna". In addition, the WFD requires that the overall ecological status of a water body is being determined by the lowest scoring biological or physicochemical quality element (i.e., the quality element worst affected by human activity). This is called the 'one out - all out' principle. For all specific pollutants (which are a sub-set of the chemical and physicochemical quality elements) with the exception of ammonia, compliance with the environmental quality standards for good status has to be consistent with classification as high or good ecological status: whether high or good is assigned can depend on the condition of the other quality elements.

4.4.3 Qualitative assessment of the benefits of reaching the targets

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 changes in pollutant discharges and the improvements in societal well-being that are not associated with direct use of the affected ecosystem or habitat. The fact that these values exist, however, is indisputable, as evidenced, for example, by society's willingness to contribute to nature conservation organisations.

An overview of key benefits derived from improved surface water quality in Lebanon can be found in Box 4-4, which reflects the range of goods and services that are provided to society by a healthy water environment. Some of these benefits have been covered under other sections of this document.

Box 4-4 Benefits associated with surface water quality improvement	
Health benefits	– Polluted water is a minor cause of human disease and death in Lebanon. – Still, 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 disease will occur from infection from 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 more dangerous, if infrequent, bacterial diseases.
Environmental benefits	– Physical effects are translating in Lebanon into biological impact, i.e., eco-system damage and biodiversity loss. – The presence of pollutants/toxic substances in water (e.g., metals, pesticides), affect a wide range of animal, fish and vegetation, both freshwater and marine and are site specific in Lebanon such as the Qaraoun Reservoir in the Beqaa:

Box 4-4 Benefits associated with surface water quality improvement	
	○ Species may be affected by direct toxic effects on metabolism and the disruption of endocrine functions, which often impacts on the reproductive system. ○ Some substances can also be accumulators both within the environment (e.g., sediments) and within animals (bioaccumulation). Therefore they can represent a significant threat even in small concentrations. – Although not an issue in Lebanon's water courses, excessive nitrates 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 forms. Decreases in nutrient loadings thus benefit aquatic habitats. This, accompanied by lower sediment and pesticide loadings, results in increased fish and waterfowl populations.
Economic benefits	– Cleaner surface water resources in Lebanon can: ○ reduce costs to industry (e.g. for pre-treatment), ○ reduce costs to society by avoiding that the cost of remediation and of drinking water treatment, ○ stimulate the development of new environmental technologies (e.g. for water treatment), ○ avoid microbiological contamination of food crops, ○ increase fish populations and catch in some rivers (Orontes) and in marine environment, ○ enhance the potential for tourism, ○ increase the value of property – Water pollution is both a cause and an effect in linkages between agriculture (the single largest user of freshwater on a global basis) and human health: ○ Agriculture is a major contributor to 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. Such measures may include e.g. stimulating a more efficient use of fertilisers and pesticides. ○ Avoiding microbiological contamination of food crops, stemming from: 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 life habitat and thus to greatly contribute to increasing freshwater and coastal fish populations. These population increases would positively affect subsistence anglers, commercial anglers and fish sellers, and consumers of fish and fish products. – The coastal bathing areas have a strong potential for tourism. 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 local economy are secured. – 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 is affecting the quality of living in the areas nearby surface waters. – Water pollution is reducing the amenity value and tourism development benefits to local communities as this restricts the use of waters. – Improved surface water quality will favour recreational uses, such as swimming, boating, angling and outings. 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

Box 4-4 Benefits associated with surface water quality improvement	
	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.

Source: WHO website: <www.who.int>; See the methodological approach in the Benefit Assessment Manual -- Bassi et al. (2011); Authors.

4.4.4 Quantitative assessment of the benefits of reaching the targets

The baseline water quality information used from Lebanon to feed the benefits transfer model indicates that presently 100% of the catchment area of rivers and lakes in the country fails to achieve Good Ecological State (GES) according to the WFD.

The targets used for the assessment are those which have been used by the original valuation study, which are (as a target for their models) compliance with the WFD at national level. WTP values as presented in Baker et al. (2007) relate to a permanent increase in real annual payments (increase in water bills and other expenses) that a household is willing to pay for reaching two alternative scenarios of 75% to 95% of all water bodies in the country reaching GES by certain key dates (2015, 2022 and 2027).

In the case of Lebanon, the quantitative target is the following: 85% (as an average between 75% and 95%) of all surface area of rivers, lakes and reservoirs in the country will be improved to GES by 2020.

The improvement of water quality by bringing the value of faecal streptococci to less than 200 per 100 ml could reduce the prevalence of gastrointestinal (GI) and acute febrile respiratory illness (AFRI) among coastal bathers from 18,545 and 13,326 cases respectively in 2008 by 6,812 and 2,157 cases respectively in 2020 (Table 4-13 and Table 4-14).

Table 4-13 Burden of disease associated with coastal swimming – Lebanon, 2008

Coastal bathing area	Area with poor bathing water quality	Number of bathers 2008	GI # of cases		AFRI # of cases		GI # of cases midpoint	AFRI # of cases midpoint
			low	high	low	high		
BML	5 bad	85,802	8,580	12,870	-	1,630	10,725	6,435
	1 moderate	17,160	172	858	669	858	515	764
SL	2 bad	24,533	2,453	3,680	-	466	3,067	1,840
	2 moderate	24,533	245	1,227	957	1,227	736	1,092
NL	2 bad	18,934	1,893	2,840	-	360	2,367	1,420
	4 moderate	37,867	379	1,893	1,477	1,893	1,136	1,685
Total	16 out of 27	208,830	13,722	23,368	3,103	6,434	18,545	13,236

Note: it is assumed that 10% of the population in each region goes sea swimming despite the quality of water and is distributed equally along the swimming areas (derived from Figure 4.3). Tourists are not considered in the analysis.

Source: See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); Authors.

Table 4-14 Possible burden of disease associated with coastal swimming – Lebanon, 2020

Coastal bathing area	Area with poor bathing water quality	Number of bathers 2020	GI # of cases		AFRI # of cases		GI # of cases reduced	AFRI # of cases reduced
			low	high	low	high		
BML	5 bad	93,294	9,329	13,994	-	1,773	2,799	886
	1 moderate	18,659	187	933	728	933	560	177
SL	2 bad	26,675	2,668	4,001	-	507	800	253
	2 moderate	26,675	267	1,334	1,040	1,334	800	253
NL	2 bad	20,587	2,059	3,088	-	391	618	196
	4 moderate	41,173	412	2,059	1,606	2,059	1,235	391
Total	16 out of 27	227,063	14,921	25,409	3,374	6,996	6,812	2,157

Note: it is assumed that 10% of the population in each region goes sea swimming despite the quality of water and the population is distributed equally along the swimming areas (derived from Figure 4.3). Tourists are not considered in the analysis.
Source: See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

4.4.5 Monetary assessment of the benefits of reaching the targets

This section illustrates the range of monetary benefits in Lebanon from an improvement in water quality from current conditions to GES, which is the overarching environmental objective of the EC Water Framework Directive (WFD). The monetary benefits are equal to the estimated amount of money that households in Lebanon would be willing to pay for improved surface water quality by 2020.

The following are important aspects to take into consideration when making use of the results reported below: 1) only people resident in Lebanon are considered. any possible value that visitors to the country may have 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, although the types of values outlined in Annex I Surface Water Benefit Transfer in Table A.1 are all covered in the analysis; 3) the analysis illustrates a portion of the TEV of water quality improvements in Lebanon, only valuation of people's preferences for changes in quality are included here, other chapters illustrate other types of values; and 4) it has been assumed that all water bodies in the 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.

Table 4-15 shows the results of the transfer of estimated economic values of water for the United Kingdom in Baker et al. (2007) to Lebanon. Mean WTP values for the 85% overall water quality improvement scenario in Lebanon ranges between € PPP 59.6 and € PPP 214.4 per year per household depending on the two payment mechanisms used in the original contingent valuation method employed in Baker et al. (2007). Results are shown in a range to illustrate the degree of uncertainty associated with the benefits estimates that were elicited through a survey that used the Contingent Valuation (CV) methodology using both payment card (PCCV) and dichotomous choice (DCCV) as payment mechanisms. The lower end of the range represents mean values of the PCCV format and the upper-bound range is derived from the DCCV model. The benefit transfer provides "order of magnitude" results, in

order to communicate the scale and significance of the potential benefits arising from improved surface water quality.

Table 4-15 Benefits of meeting water quality improvement targets – Lebanon, 2020

2020 WTP results € PPP per HH year		**2020 WTP results** LP per HH year		**2020 Target** € PPP million		**2020 Target** LP billion		**% of 2020 GDP**
Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Midpoint
59.6	214.4	85,632	308,009	59.4	213.6	85.3	306.9	0.3%

Source: See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

Multiplying WTP values by 996,522 number of households projected in 2020, gives a total benefit figure for WFD related water quality improvements in Lebanon by 2020 in the range of € PPP 59.4 million - € PPP 213.6 million. In terms of 2020 GDP share these figures are in the range 0.13% - 0.45% (Table 4-15).

4.5 Benefits from reducing water resource scarcity

Management of water requires balancing the needs of people and economic development through agriculture, industry and municipal uses, and environmental requirements so that it continues to sustain the ecosystems on which humans depend. This section provides an assessment of water scarcity and the benefits associated with reducing water scarcity and improving integrated water resource management.

It does this through assessing the level of water availability, threats to water availability and the primary uses of water. It predominantly involves undertaking a qualitative assessment of benefits that include for example, reduced crop loss due to drought, reduced losses through fish kills due to low river flows and improved access to and along waterways.

Where water scarcity is an issue, both a demand-led and supply-led approach to 'integrated water resource management' should be adopted, focusing on conserving water and using it more efficiently, to complement appropriate capture and storage of water. Water parameters are defined in Box 4-5.

Box 4-5 Definitions of water parameters

Water scarcity is defined as 'the point at which the aggregate impact of all users impinges on the supply or quality of water under prevailing institutional arrangements to the extent that the demand by all sectors, including the environment, cannot be satisfied fully'. Water scarcity is a relative concept and can occur at any level of supply or demand. Scarcity may be a social construct (a product of affluence, expectations and customary behaviour) or the consequence of altered supply patterns - stemming from climate change for example. In this case, water resource scarcity is taken to cover the availability of renewable freshwater and the extent of its use.

A key parameter to assess water scarcity is the Total Actual Renewable Water Resources (TARWR), used in this section. TARWR is the maximum theoretical amount of water actually available for the country, generally calculated from:
(a) Sources of water within a country itself (ground water and surface water, less any overlap effectively shared as it interacts and flows in both the groundwater and surface water systems);

(b) water flowing into a country
(c) water flowing out of a country (treaty commitments).
In this calculation TARWR is added to the water obtained by desalination (potable water obtained from treatment of saltwater) and waste water re-use (Water obtained from treatment of waste water available for re-use).

According to the European Environment Agency (2009), one relatively straightforward indicator of the pressure or stress on freshwater resources is the Water Exploitation Index (WEI) (also known as the Water Stress Index and Relative Water Stress Index). This is calculated annually as the ratio of total freshwater abstracted (withdrawal) to the Total Actual Renewable Water Resource (TARWR). A WEI above 20% implies that a water resource is under stress and values above 40% indicate severe water stress (Raskin et al., 1997).
Water Exploitation Index = Total withdrawal per year / TARWR

In addition, the UN indicates that hydrologists typically assess water scarcity by looking at the water available per Capita. An area is considered to experience water stress when annual water supplies drop below 1,700 m^3 per person. When annual water supplies drop below 1,000 m^3 per person, the population faces water scarcity, and below 500 m^3 "absolute scarcity".

In this section, a number of water scarcity indices are covered, as defined below:

- Water Available per Capita = TARWR/population
- Total Water Use per Capita = Total withdrawal per year / population
- Municipal Water Use per Capita = Municipal withdrawal per year / population

The main uses of water covered in this assessment are:

- **Agricultural water:** Water supplied to crop production, animal husbandry, hunting, fishing, and forestry.
- **Municipal water:** Water supplied to the community and individuals.
- **Industrial water:** Water supplied for the production of non-food products.

These uses must be addressed in the context of environmental requirements, in this document this is quantified by environmental flows which is 'the streamflow required to maintain appropriate environmental conditions in a waterway'.
Water reuse is not covered in this context but could help augment water supply for selected irrigation, industrial and domestic purposes.

Source: EEA (2009); FAO (2003); and UN website: <www.un.org/waterforlifedecade/scarcity.htm>.

4.5.1 Current state

Considered a water scarce country with 1,090 m^3 per capita in 2009, Lebanon's water resources are mismanaged although it is, relative to the region, well endowed with surface water, underground water and untapped marine springs. Climate change affects will reduce precipitation levels by 7% with an increase of 1°C and affect agricultural yield (Box 4-6).

Box 4-6 Water resources and agriculture sector vulnerability and adaptation - Lebanon

Water resources will be affected by climate change with lower precipitation and spatial and temporal (main precipitation will occur in November and December) projected changes that will be exacerbated by evapotranspiration and droughts. A reduction of 6 to 8% of the total volume of water resources is expected with an increase of 1°Celsius and 12 to 16% for an increase of 2°C.
The main adaptation measures of the water sector include: (i) the protection of groundwater from salinisation in coastal areas; (ii) the implementation of water demand side management strategies to reduce domestic, industrial and agricultural water demand; (iii) the development of watershed management plans; and (iv) the implementation of pilot initiatives to demonstrate the feasibility of alternative sources of water supply such as water reuse and develop necessary standards and guidelines.
Agriculture will be hard hit by higher temperature, reduced precipitation and high evapotranspiration as the

combination of these factors will decrease soil moisture, increase aridity, and increase the infestation of fungi and bacterial diseases, which will affect the overall agricultural crop yield. Fruit crops will be the hardest hit in mountainous areas, e.g., grapes and the production of wine with more pressures in these areas as some plantations will have to be shifted from the coast to higher altitude, e.g., bananas and tomatoes. Irrigated crops will face water shortages and the productivity of rainfed crop will remain unchanged or decrease in certain regions. The grazing period and the quality of the pastures will be affected by rising temperatures and less rainfall as longer grazing seasons are expected in high-altitude regions with the reduced seasonal duration of the snow cover.

The main adaptation measures of the agriculture sector include: (i) the selection and introduction of more drought and heat-resistant species and hybrids; (ii) the change in planting dates and cropping patterns; (iii) the adoption of sustainable agricultural practices and integrated pest management techniques; (iv) the elaboration of a national rangeland program; (v) the enhancement of genetic selection of local breeds; and (vi) and the promotion of mixed exploitations.

Source: MOE (2011a).

Lebanon's actual renewable water is estimated at 4,550 million m^3 on average per year with large variations according to sources (Table 4.16) although climate change affects are expected to negatively affect both precipitations (-13% by 2040) and runoff (-15% by 2040) in the future,[55] and could reduce the GDP by 2 to 5%. Underground water is estimated at 700 million m^3 on average per year and there are small desalination units managed by beach resorts (50 million m^3) whereas untreated water reuse (2 million m^3), which is not regulated in Lebanon although FAO has recently produced some guidelines,[56] supplies agricultural areas during the dry season, notably in the upper Beqaa (Table 4-16).

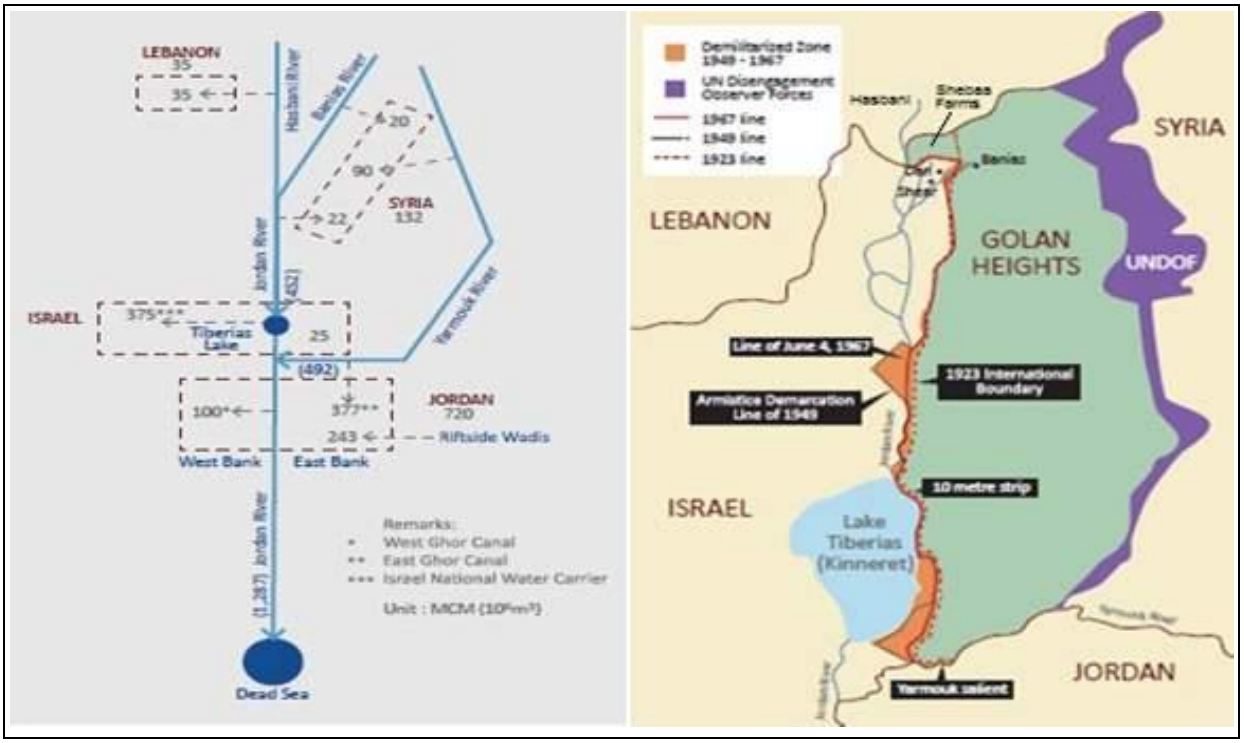
Table 4-16 Water resources - Lebanon

Water Resources	**Water available** Km^3/year = 10^9m^3/year
Surface water (SW)	3.80
% SW from neighbours	0.0
Ground water (GW) recharge	3.20
Less overlap of GW and SW	-2.5
Desalinated Water	0.05
Waste water reused	0.002
Total Actual Renewable Water of which:	**4.55**
Outflows to neighbouring countries	*0.5*

Source: FAO (2009); See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

55 METAP (2009b).
56 FAO (2010a,b).

Figure 4.4 1954 Johnston Plan water sharing & border and river overlap – Lebanon



Source: Adapted from SFG (2011).

Also, the total outflows to neighbouring countries are estimated at 500 million m^3 or 11% of actual renewable water (Table 4-17). However, various citations suggest an average yearly surface source outflow ranging between 300 and 700 million m^3, and groundwater outflow ranging between 150 to 310 million m^3 (Table 4-17). Most bilateral treaties or indirect agreements on water sharing were however negotiated outside the thrust of the 1997 UN Convention on Transboundary Water Courses. Along the northern border, a treaty was ratified with Syria in 2002 on the Orontes that allows Lebanon the right to store 38 million m^3 in two dams, to produce electricity and to irrigate 6,600 hectares (ha) in the Qaa and the Beqaa. For El Kebir River, another treaty was ratified in 2002 with Syria leading to water rights sharing between Lebanon (40%) and Syria (60%), and the implementation of a 70 million m^3 dam with both countries equitably sharing the costs. Along the southern border, the Jordan River and its upstream tributaries is at the confluence of a power struggle between riparian states that are inequitably abstracting water upstream that has reduced the flow of the river from 1.3 billion m^3 annually in 1930 to a mere 20 to 30 million m^3 in 2008 following the construction of the dams that are regulating its flow.[57] Due to the state of war between Lebanon and Israel, indirect talks have allowed Lebanon to only use 8 million m^3 per year from the Hasbani River and its tributary, the Wazzani, although the 1954 Johnston Plan that is not currently implemented allowed for the use of 35 million m^3 (Figure 4.4). Moreover, the occupation by Israel of Lebanon Shebaa farms allows Israel to control the aquifer, notably the rivers feeding into the Upper Jordan River, i.e., the Hasbani River, the Dan River that flows into Israel and the Banias River that originates in the occupied Golan Heights. The mean annual flow of the Upper Jordan River system is estimated to be ~1300 million m^3 of which ~47% is abstracted by Israel, 22% by Jordan, 16% by Syria, and 2%

57 Le Monde (July 23, 2010).

by Lebanon, leaving only 13% of the flow to enter the Dead Sea.[58] When coupling a dynamical downscaling model (RegCM3) to a hydrological model (HYMKE) to evaluate the impact of climate change on the upper catchment of the River Jordan and its tributaries: with a 10% reduction in rainfall, base and surface flows decline by 10% and 17% respectively.[59] In conclusion, when the dams will be finalized on the El Kabir and Orontes rivers, Lebanon will be able to use about 11.1% of its water resource outflows excluding the underground resources available in the occupied Shebaa Farms.

Table 4-17 Alternative citations with water resource flows - Lebanon

Description	Unit	MED EUWI (2009)	MOEW (2004)	World Bank (2003)	Geadeah (2002)	Plassard (1971)	UNDP (1970)
Precipitation	mm	800-1,000	820	820			940
Evapotranspiration	mm	500-600	430	380			
Precipitation	Mm^3	8,320-10,400	8,600	8,600	8,600	8,600	9,800
Evapotranspiration	Mm^3	4,300-6,240	4,500	4,000	4,300	4,300	
Total flow: 40 streams	Mm^3	3,673-4,800	3,680	3,800	1,174	1,800	4,300
Surface water outflow	Mm^3	300-670	945	700	670	(north) 510 (south) 160	~680
Groundwater outflow	Mm^3	310		200	300	(south) 150	
Submarine flow	Mm^3	385-1,000	385	700	880	880	711
Total resources average	Mm^3	2,600-4,800					
Total resources dry season	Mm^3	*1,400-2,200*					
Exploitable: surface	Mm^3	1,500					
Exploitable: ground	Mm^3	700-1,165					
Exploitable: total	Mm^3	1,400-2,200			2,000	2,200	

Source: MOE (2011a) citing the sources in the Table.

Total water use in Lebanon is about 1.31 million m^3 on average per year allocated as follows:[60] 25% for domestic, 11% for industrial and 64% for irrigation use (Table 4-18). The figures provided by the MOEW in the 2010 National Water Sector Strategy are more on the conservative side with 987 million m^3 on average per year with: surface abstraction reaching 369 million m^3 (exploitable could reach 1,233 million m^3); and underground water, which is poorly studied in Lebanon although the overexploitation of these resources is affecting the water quality, reaching 260 million m^3 extracted by the RWEs, 182.3 million m^3 by licensed private wells and 175.6 million m^3 by unlicensed wells per year on average.[61]

Table 4-18 Water use - Lebanon

Water use	Total withdrawal per annum 10^9 m^3/year	% of total use
Agriculture	0.78	60%
Municipal	0.38	29%
Industry	0.15	11%
Total	**1.31**	**100%**

Source: FAO (2009); See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

58 Al-Weshah (2000) cited in Wilby (2010).
59 Samuels et al. (2010) cited in Wilby (2010).
60 MOEW (2010).
61 MOEW (2010).

The estimated water withdrawal, which is shown in Table 4-18, reveals that agricultural use dominates significantly (60%), with a reasonable proportion allocated towards municipal use (29%). This gives an overall water exploitation index (WEI[62]) of 29% (i.e., total freshwater abstracted as a proportion of total renewable water available), which implies a water stress and unsustainable use of water. Water available per capita is 1,090 m^3 per capita with almost one-third being exploited for human-made activities (Table 4-19).

Table 4-19 Water scarcity indices - Lebanon

Water index	#	Unit
Water Exploitation Index	29%	Percentage water use to availability
Water Available per Capita	1.09	10^3 m^3/person/year
Total Water Use per Capita	0.31	10^3 m^3/person/year
Municipal Water Use per Capita	0.09	10^3 m^3/person/year

Source: FAO (2009); See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

Other uses of water within Lebanon include:

- Maintaining water flows in the Ammiq wetland in the Beqaa Valley and the wildlife it supports.

Some of the current problems and threats relating to water resource scarcity in Lebanon include:

- In drought years, the reduction of the snow cap on the mountains reduces the actual renewable water and increase the vulnerability of the entire country in terms of agriculture (mostly areas prone to desertification);
- Water losses in the distribution system are estimated to be around 40% per year due to the old infrastructure, which is about 152 million m^3;
- Water losses in the irrigation system are equally putting a strain on the resource especially since the cost recovery is very low and the unit irrigation tariff amounted to less than half of unit O&M costs. Plans to expand cultivated areas are underway with the introduction with cost efficient irrigation systems though.
- Most of the main sources of drinking water and the catchment areas are prone to bacterial pollution such as the Jeita Grotto that is also a natural heritage attraction.
- The aquifer over-abstraction through 4,000 licensed and unlicensed wells are depleting the resources and increasing the risk of bacteriological contamination and salt intrusion.
- Many rivers run dry during the summer months, particularly during droughts and could be managed to regulate the flows due to the implementation of hill lakes or dams.
- Salinisation has affected the coastal cluster of irrigated agricultural land (total agricultural land covered an area of 90,000 ha in 2010) as a result of a higher water table near the coast and evaporation of irrigation water on higher grounds are reducing agricultural yield by 15% on average.

62 Note that a WEI of over 20% implies water resources are under stress, and values above 40% imply severe stress and unsustainable use of water (Raskin et al., 1997).

- There are a number of flood prone areas in a number of cities due to poor drainage and drainage management as well as in the Beqaa (Arsal and Ras Baalbeck) with flooding being exacerbated by the land degradation: shrubs and fruit trees have been abandoned to the detriment of quarries. The floods were sometimes catastrophic and affected illegal constructions in watersheds and created havoc to the Orontes ecosystem when the floods reach the river. The UNDP is funding a project to build reservoirs to absorb the flash floods at strategic junctures. However, the infrastructure has not been tested yet.

4.5.2 Potential environmental improvements

Determining a water resource *no action* baseline for 2020 for any country is extremely difficult due to the multitude of complex factors influencing water supply and demand, requiring a detailed study of its own. Yet, the projected domestic, agriculture and industry water demand was estimated by the World Bank (2009) but is based on over-optimistic assumptions: as the population growth rate is set at 2.5% against 0.7% retained for the BA; 2003 FAO water resource baseline was retained; network losses set at 35% against currently 40%; an improvement of irrigation effectiveness (-11% over the 2010-2030 period); and a constant industrial allocation of 35% of water resources. Moreover, the climate change affects were not factored in the water supply (about 15% runoff reduction by 2040 and marginally less before).

Table 4-20 Annual water demand – Lebanon, 2010-2030

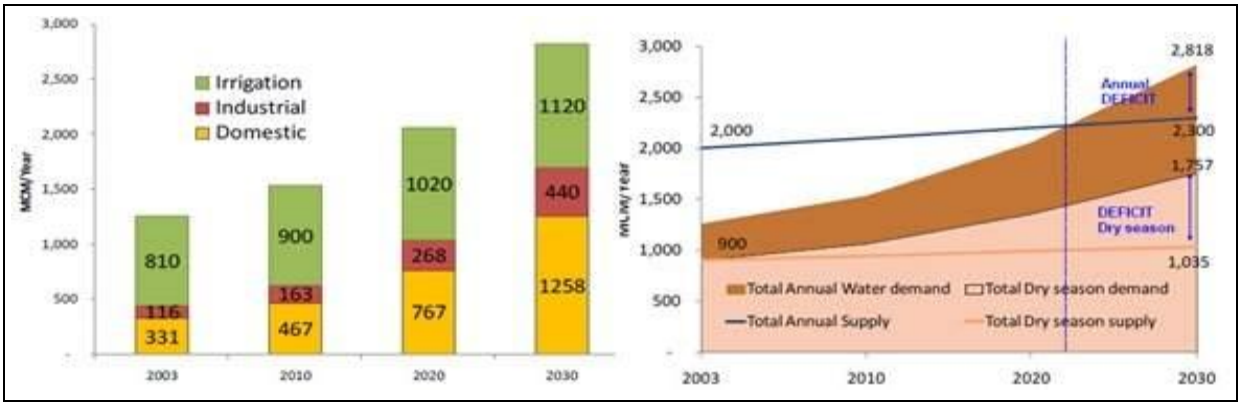
Sector	2010		2020		2030	
	Million m^3	%	Million m^3	%	Million m^3	%
Domestic	467	31	767	37	1,258	44
Industrial	163	11	268	13	440	16
Irrigation	900	58	1,020	50	1,120	40
Total	**1,530**	**100**	**2,055**	**100**	**2,818**	**100**

Note: Assumptions: Annual population growth 2.5%; Per capita water consumption 140 litre/day; Network Losses 35%; Irrigated area growing from 90,000 ha to 140,000 ha in 2030; Irrigation demand decreasing from 9,000 m^3/ha to 8,000 m^3/ha; Industrial demand equals 35% of domestic demand.
Source: World Bank (2009).

The water demand is almost doubling over the 2010-2030 periods with a demand crossing supply in 2022 (Table 4-20 and Figure 4.6). However, these figures do not account for the possibility of optimisation of water reuse and effective improvement of water irrigation and distribution, etc. The Water sector has 321 operational, on-going and planned projects as illustrated in Figure 4.6 with a total envelope of LP 3,675 billion or € PPP 2.8 billion until 2015. The 2010 National Water Sector Strategy calls for the improvement of the sector effectiveness, efficiency and equity by addressing the legal (introducing the water code), institutional (clarify responsibilities and function between the MOEW and RWEs), regulatory (privatisation is on hold by Parliament but contract managements are being adopted), physical (increase supply, improve drought and flood management, reduce unaccounted for water, penalise unlicensed wells and drilling, introduce water reuse, improve distribution effectiveness and ensure year round water quality, quantity and regularity, restore ecosystem services in dried-up areas, municipal, industrial and agricultural discharge pollution management), management (build capacity and improve governance) and financial

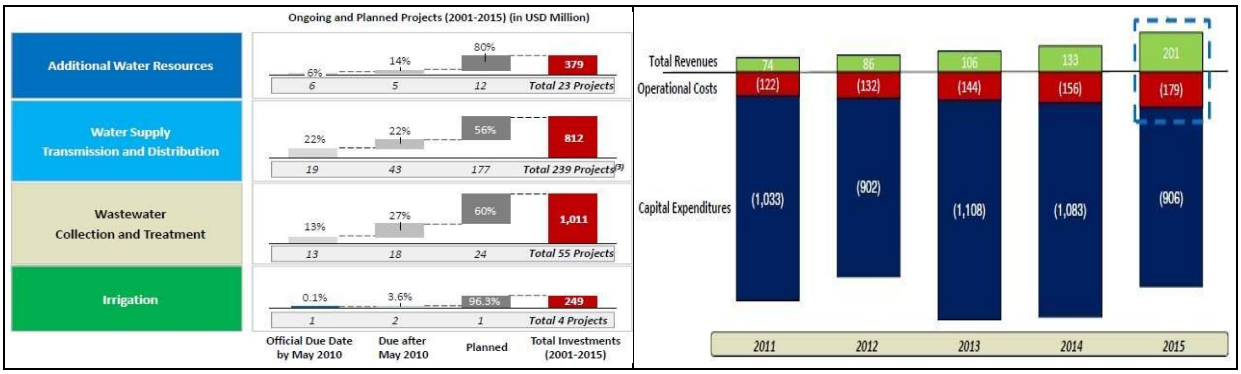
(achieve partial O&M and even total (capital) cost recovery) deficiencies to be achieved by 2015.

Figure 4.5 Water demand and supply - Lebanon, 2003-2030



Source: World Bank (2009).

Figure 4.6 Water sector investments and cost recovery - Lebanon, 2011-2015



Source: MOEW (2010).

Yet, it does not seem that the improvements are partly demand-led (introducing of meters and volumetric tariffs, etc.) and these improvements will definitely lower the WEI that will be closer to 20%, which will improve the sector efficiency, effectiveness and equity across water use: domestic, industrial, irrigation and ecosystem, which will lead to improved biodiversity and ecosystem services (e.g., fisheries, recreation, etc.).

4.5.3 Qualitative assessment of the benefits of reaching the targets

Improving water resource use and management will potentially lead to a multitude of benefits that alleviate water scarcity as opposed to improving water quality (Box 4.7).

Box 4-7 Benefits associated with water resource use improvement	
Health benefits	– Significant health benefits could be gained from improving drinking water quality through a reduction in disease. 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.

Environmental benefits	– If environmental flows are maintained within rivers and lakes, fish species diversity and abundance will be maintained and enhanced. There will be more water available to maintain and enhance the broad range of habitats and species that depend upon there being certain water levels within wetlands, rivers and lakes.
Economic benefits	– There could be substantial gains in economic productivity of agricultural output if agricultural water use and irrigation were better managed. This would include increased agricultural output through more efficient irrigation and reduced salinisation. In addition, there would be a reduced loss of crops and livestock during periods of drought.
Social benefits	– If the environmental integrity of rivers and wetland habitats are maintained, and they do not run dry, they can enhance the quality of life of those people living nearby. This can arise through both recreational use of the water bodies. In addition, there may be some cultural and spiritual benefits (non-use benefits) to some people from maintaining nearby water bodies. In some cases there may be benefits relating to improving the environment for tourism, which is likely to increase in the future.

Source: See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

4.5.4 Quantitative assessment of the benefits of reaching the targets

This study has not attempted to quantify the benefits of improved water resource management, and little directly relevant quantitative data was readily available.

4.5.5 Monetary assessment of the benefits of reaching the targets

This study has not attempted to assess the monetary value of improved water resource management, and no relevant valuation studies were identified on Lebanon. However, potential economic losses associated with droughts and reduced crop outputs can be substantial.

5 BENEFITS OF IMPROVING WASTE RELATED CONDITIONS

5.1 Introduction to waste related issues

The legislative, institutional and regulatory reform initiated at the end of the 1990s is unfinished and impedes proper management of the solid waste sector. Existing legislation consists of fragmented regulations not specifically dealing with solid waste. The solid waste sector services, which received investments and O&M representing 70% of the water and waste water investments and O&M over the last 10 years, remain uneven: waste collection is effective, inefficient and partially equitable across regions; waste treatment and disposal remain ineffective, inefficient and inequitable across regions. Methane from several closed and operational dumps/landfills is still being burnt and not captured.

When benchmarked with other Middle Eastern countries, the solid waste management (MSW) € PPP 117.4 cost per ton of and 366 kg generated per capita per year are the highest with 50% organic composition. Solid waste management cost is almost split evenly between collection and treatment/disposal although proper disposal is only provided in 4 landfills absorbing 54% of waste generated: Nahmeh and Bsalim sanitary landfills in BML, which are close to full capacity; Zahleh sanitary landfill in BB; and Tripoli landfill in NL. Waste recycling and composting is estimated at 15% leaving a residual of 31% that is being dumped in nature, riverbeds and the sea. Dumped waste is occasionally burned. The MOE and CDR have formulated a revised MSW strategy in 2010 which notably: defined 4 service areas (BML, SL, NL and BB); assigned the collection and transfer responsibility to municipalities, and treatment and disposal to the Government; suggested power generation through waste-to-energy (BML and Tripoli) and fuel cells, and carbon funding; encouraged private participation (from management to Built-Operate-Transfer); and called for the elaboration of awareness campaigns.[63] Moreover, the MOE has formulated an action plan in May 2011 to rehabilitate 670 dumping sites of which 504 are used for municipal waste and 166 are used for construction and demolition (C&D). The estimated rehabilitation cost amounts to LP 10.2 billion.[64]

The benefits of a sound waste management system expand beyond keeping the day-to-day living environment in the cities clean and tidy. Waste management generates mainly benefits in the field of hygiene through the abatement of fly tipping or wild burning both in cities and rural areas, on protection of surface and ground water, on avoiding air pollution, on landscape care, environmentalism and tourism, on CO_2 emissions and climate change, on resource depletion, on energy production and on availability of secondary raw materials from the recycling industry. A sound waste management system contributes to social benefits through job creation.

This section will cover the following aspects of waste management:

- Waste collection coverage
- Illegal /uncontrolled dumping of waste
- Methane emissions

63 World Bank (2011).
64 L'Orient Le Jour (May 20, 2011).

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.

5.2 Municipal solid waste collection coverage

5.2.1 Current state

Municipal solid waste collection coverage including construction debris and excluding medical and hazardous waste has improved over the years with: 100% coverage in BML and about 95% coverage for SL, NL and BB bringing the total collection to 99%. So has urban sweeping that usually is bundled with solid waste collection contracts. Collection and sweeping has been contracted out to large and small private firms: 4 large companies are handling collection in Greater Tripoli, Saida, the federation of municipalities of Jezzine and BML except for the Caza of Jbeil. These companies are paid through the independent municipal fund that is housed at the Ministry of Finance and is replenished thanks to indirect taxes collected by the central government on behalf of municipalities. In case of a backlog of the Independent Municipal Fund, the treasury advances the funds. All the other municipalities have contracted out small firms that they pay through their own budgets.[65]

Average waste generation

The average waste generation of the urban population (people living in large towns) ranges between 0.75 and 1.1 kg per capita per day, while that of the rural population (dispersedly living people or inhabitants of small towns) ranges between 0.5 and 0.7 kg per capita per day. The total average waste generation was estimated at 366 kg per capita per year in 2008.

Waste collection coverage

The waste collection service coverage is 99% for the whole country with 100% in BML and 95% in the rest of the country.

Dumped municipal waste volume

The total amount of non-collected municipal waste in 2008 which is dumped in a non controlled way is considered to be equivalent to 1% thus amounting to 14,091 tons.

Management of waste

Composting represents 9% and recycling 8-9%. The remaining waste is either disposed in landfills (51%) or dumped (31%). The total amount of collected municipal waste in 2008 which is dumped in a non controlled way is considered to be equivalent to 31% thus amounting to 436,822 tons.

65 World Bank (2011).

2020 Baseline

The baseline from now to 2020 is a business-as-usual situation in which the collection coverage does not increase or decline. It is fully defined by demographic evolution and by the evolution of the average generation of waste per capita, in line with augmenting GDP. The results are illustrated in Table 5-1.

Table 5-1 Baseline total municipal waste generation - Lebanon

Year	Population # million	GDP € billion	Waste generation Kg/capita/year	Waste generation Million tons/year
2008	4.2	19.9	366	1.4
2020	4.6	27.8	621	2.1

Source: See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

The total amount of non-collected municipal waste in 2020 which is dumped in a non controlled way is equivalent to 1% and amounts to 14,091 tons.

When assuming a shift in the composition of the generated municipal waste between now and 2020, in line with shifts in lifestyle, the future generation of different waste fractions are illustrated in Table 5-2.

Table 5-2 Baseline shift in waste composition - Lebanon

Waste	Actual composition 2008		Future composition 2020	
	tons/year	%	tons/year	%
Organic waste	704,551	50	956,069	44.6
Plastics	70,455	5	129,361	6.0
Paper/cardboard	112,728	8	191,359	8.9
Glass	112,728	8	176,919	8.3
Textile	56,364	4	75,357	3.5
Metal	56,364	4	82,600	3.9
Inert	211,365	15	369,258	17.2
Other	84,546	6	145,126	6.8
Total	**1,409,103**	**100**	**2,141,580**	**100**

Source: See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

2020 Target

The 2020 target is a full coverage of the total population, rural and urban, in 2020 by increasing the collection from 99% to 100%. Increased collection leads to less waste sent to dumpsites or wild burning, and thus a reduced negative impact on the environment and human health. Moreover, solid waste management could increase economic efficiencies.

Table 5-3 Baseline of 100% collection coverage – Lebanon, 2020

Year	Waste generation Million tons/year	Collection Coverage %	Waste Collected Million tons/year
2008	1.4	99	1.4
2020	2.1	100	2.1

Source: See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

The yearly increase of MSW coverage is as follows (Table 5-3):

- 99% of the population covered by municipal waste collection in 2008
- 100% of the population covered by municipal waste collection in 2020

5.2.2 Potential environmental improvements

The environmental improvement of reaching the collection targets is based on the amount of waste for which non-controlled disposal is avoided. It is the difference between the total amount of dumped waste in the business-as-usual scenario in 2020 and the total amount of dumped waste in the collection-coverage-target compliant scenario in 2020. We are assuming that according to the target-compliant-scenario collection will evolve towards 100% coverage of all waste generated in 2020 with an improvement of 14,091 tons.

5.2.3 Qualitative assessment of the benefits of reaching the targets

An overview of key benefits derived from improved solid waste management in Lebanon can be found in Box 5-1, which reflects the range of goods and services that are provided to society by a healthy environment free of open dumps. Some of these benefits have been covered under other sections of this document.

Box 5-1 Benefits associated with solid waste management improvement	
Health benefits	– Reduction of risk associated with transmission of communicable diseases including vector-borne diseases spread by sandfly, rodents, etc.
Environmental benefits	Positive effects on cultivated land, landscape and ecosystems through the: – Reduction of soil contamination – Reduction of watershed contamination – Reduction of groundwater contamination – Reduction of coastal and sea-bound contamination – Reduction of the risk of forest fires – Reduction of the release of air pollution (burning) and greenhouse gases (methane) with all the associated health, yield, productivity and global externalities effects
Economic benefits	Positive effects on tourism revenues, agricultural yield, industrial productivity and fish catch. Private sector participation that increases efficiency and effectiveness with job creation Business development and additional revenues from recycling, composting, electricity generation and carbon funding.
Social benefits	Cleaner environments that: – Reduce sight and odour pollution – Increase amenities

Source: See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

5.2.4 Quantitative assessment of the benefits of reaching the targets

The quantitative assessment of environmental benefits focuses on the benefits of reducing the size of land polluted by uncollected waste/dumpsites, thanks to the expansion of the collection coverage; and by the avoided disposed waste due to recycling and composting.

Following assumptions are used:

- Average dumpsite depth of 1 meter;

- Average density of dumped waste of 340 kg/m³;
- Two-thirds reduction in volume through uncontrolled fires at the dumpsites.

The total non-collected municipal waste generated in 2020 is equivalent to 0.02 km^2 polluted land avoided.

5.2.5 Monetary assessment of the benefits of reaching the targets

The waste diverted from the landfills is assumed to amount to € PPP 20 per m^2. The WTP equivalent of 1% of household income is considered to determine the benefits associated with better waste management for the 1% inhabitants lacking collection.

The total population supplementary served is 1% of 4.6 million people in 2020 or 46,000 people. The average income is assessed at € PPP 8,053 (Gross National Income per capita, US$ PPP current international, 2008 ~ recalculated in € PPP). However this over-estimation will be even out by applying the average income of 2008 for the year 2020 without taking into account GDP growth. The total income of the supplementary served population would be (46,000 * 8,053) € PPP 370.4 million. The willingness to pay of 1% of the income of the unserved inhabitants is thus roughly assessed at € PPP 3.7 million.

The monetary value results of extended waste collection coverage and avoided disposed waste are illustrated in Table 5.4 with total benefits amounting to € PPP 3.7 million equivalent to 0.01% of 2020 GDP.

Table 5-4 Benefits related to the non-collected waste avoided - Lebanon, 2020

Coverage	2020 Target € PPP million	2020 Target LP billion	% of GDP
Collection coverage brought to 100%	3.7	4.8	0.01

Source: See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

5.3 Waste treatment

5.3.1 Current state

The recycling business is picking up but it is fragmented as development partners through multiple actors, private entrepreneurs and community-based initiatives are involved in recycling. The Italian Cooperation has funded a solid waste recycling guide that helps municipalities determine recyclable materials and provides names and contacts of recycling companies by recyclable product all over Lebanon. Table 5-5 illustrates the cost per ton that could be generated for the various recyclable materials in 2010.

Several actors have directly or indirectly been involved in the composting and recycling infrastructure: USAID has assisted eight rural agglomerations, and financed sorting and composting to the tune of € 4.4 million with a capacity of 514 tons per day targeting 550,000 inhabitants;[66] a number of small sorting and composting plants have been established through the Office of Minister of State for Administrative Reform (OMSAR) financed by the EC to the tune of € 8.9 million with about 500,000 people targeted with a 480 tons per day

66 USAID website: <www.usaid.gov>.

capacity; the private sector is taking advantage of the waste opportunities by leveraging public or development partner funds to build and operate nine decentralised facilities in communities of around 25,000 people with the aim to increase recycling and composting to more than 90% of waste generated, whereas a Built-Operate-Transfer facility for sorting has been built in Saida, however, the suggested € 100 processed ton to be charged to the municipality of Saida is still being negotiated; and 20 women have initiated the *Sorting of Solid Waste in Arabsalim* project in Southern Lebanon in 1995 and Nida' Al Ard Association was initiated from bare necessities (health and environment concerns) and is being sustained through voluntarism and a close collaboration with a number of line ministries (MOE, MOI), the municipality, Development Partners (UN Life Program), philanthropists, schools and universities contributed toward the success of the association's experiment, later to become a licensed organisation that has developed a replicable sustainable rural solid waste recycling management. The Arabsalim initiative showcases a strong public determination towards successful cooperation in a commons dilemma situation.[67]

Table 5-5 Recyclable and compost selling price – Lebanon

Product	Glass	Plastic (HDPE-LDPE-PET)	Metal (Tin & Aluminium)	Compost certified grade	Paper	Cardboard	Textiles (without buttons)
	€ PPP/ton	€ PPP/ton	€ PPP/ton	€ PPP/ton	€ PPP/ton	€ PPP/ton	€ PPP/ton
Recyclable selling price[1]	33.3	118.5	296.3	55.6	44.4	51.9	37.0
Recyclable selling price[2]	31.5	92.6	74.1 (aluminium) 25.9 (metal)		48.1		

Source: [1]exchange with Cedar Environmental manager; and [2]exchange with OMSAR staff (2011).

Two private companies are working on landfilling with no built in incentives to increase recycling and composting, e.g., there is no recycling facilities in Tripoli, which is pushing the operators to landfill all the generated waste (nevertheless an EC-funded recycling facility is being built), and the contractual specifications for Beirut and parts of Mount Lebanon stipulate that 10% of solid waste should be recycled and 50 should be composted. Nevertheless, these contractual specifications were never enforced and therefore achieved, which unfortunately led to additional waste disposal that reduced the lifespan of the Nahmeh landfill. Conversely, Zahleh municipality that is managing the waste treatment understood the necessity to increase the recycling and composting capacity that was funded by USAID, which led to the increase of the landfill lifespan from 17 years to 26 years and reduced both its treatment and disposal O&M cost by two third.[68]

2020 Baseline

The baseline scenario describes what will happen if average waste generation grows in line with GDP and if total waste generation grows in line with demography, as described above, and if the actual waste treatment options remain unchanged. Table 5-6 illustrates the business as usual if the handling of waste remains the same, i.e., coverage, treatment, landfilling and dumping remain at the same rates in 2020.

67 Center for Development Services website: <www.neareast.org>.
68 World Bank (2011).

Table 5-6 Baseline scenario for waste treatment - Lebanon

Year	Waste generated tons	Collection coverage tons	Waste not collected tons	Waste dumped tons	Waste landfilled tons	Waste recycled tons	Waste composted tons
2008	1,409,103	1,395,012	14,091	432,454	753,306	139,501	69,751
2020	2,141,580	2,141,580	0	663,890	1,156,453	214,158	107,079

Source: See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

2020 Target

Waste prevention policy has been recently introduced at EU level and in most of its member States. No quantitative results on this policy can yet be observed on quantities of waste generated. We propose not to take waste prevention effects already in account for Lebanon. The target for waste generation is therefore equal to the baseline. For this reason benefits like reduction of resource depletion will not be tackled directly but within the frame of recycling.

Here are the assumptions for calculation as the benefits will accrue from reselling the recycled material:

- 100% reduction in illegal dumping/disposal to landfills with no environmental control;
- 50% recycling of all generated glass, paper, plastic, metals in municipal waste;
- 70% recycling of C&D waste;
- 65% of the quantity of biodegradable waste generated in 2010 diverted from landfills.

The horizon of reaching these ambitious targets is set at 2030. The calculated results will show the progress reached in 2020 for which the benefits are calculated:

- 50% recycling of glass: 243,962 generated and 121,981 targeted;
- 50% recycling of paper: 528,516 generated and 264,258 targeted;
- 50% recycling of plastic: 213,466 generated and 106,733 targeted;
- 50% recycling of metals: 121,981 generated and 60,990 targeted;
- 50% recycling of paper: 304,952 generated and 152,476 targeted; and
- 65% landfill diversion of biodegradable waste: 915,563 generated and 595,116 targeted.

5.3.2 Potential environmental improvements

The environmental improvements are:

- The amount of waste not being illegally dumped or treated in a substandard way, but being either landfilled, composted or recycled;
- the amount of waste not being landfilled but composted or recycled.

A scenario is developed in which the targets have been reached in 2030, and in which the appropriate distance to target has been bridged in 2020.

Table 5-7 Solid waste targets reached by midway – Lebanon, 2030

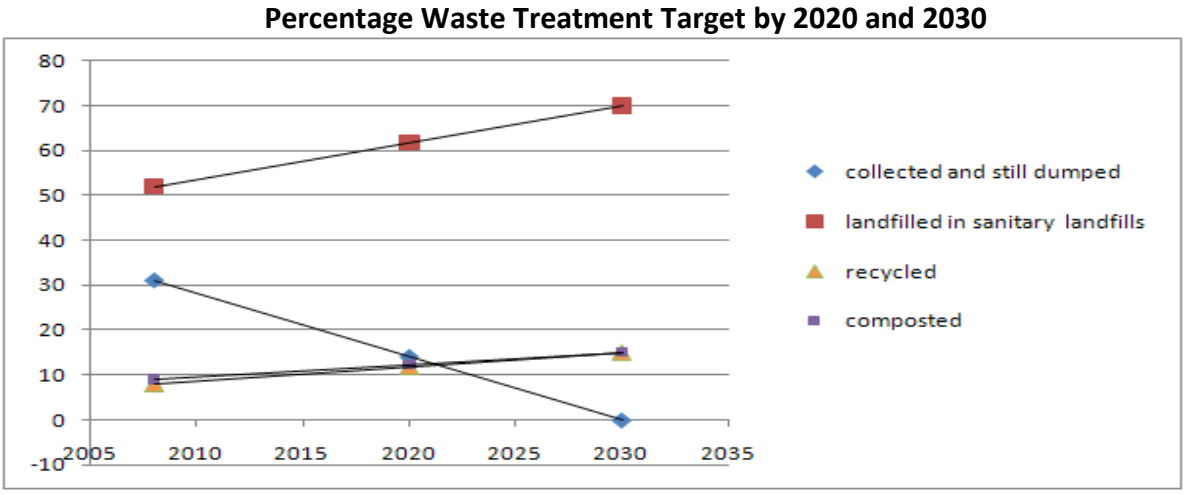
Targets	%	Calculated value for 2030	Target value for 2030	Distance to 2030 target	Evaluation
		Tons	Tons	Tons	2030 Target
% collected waste dumped in uncontrolled dumpsites	0				
% landfilled in controlled landfills	70	2,124,836	2,443,104	-318,268	target reached
% recycled	15	455,322	440,144	-15,178	target reached
% composted	15	455,322	440,602	-14,720	target reached

Source: See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

In 2030, if 70% of the generated waste would be landfilled, 15% would be recycled, and 15% would be composted, hence, the targets will have been reached. Assuming a linear progression to these targets in 2020 following waste treatment options have to be reached (Table 5-7):

- 14,091 tons or 1% of waste not being collected (Table 5-6);
- 301,963 tons or 14.1% collected waste still dumped in uncontrolled dumpsites;
- 1,323,496 or 61.8% landfilled in controlled landfills;
- 252,706 or 11.8% recycled; and
- 263,414 or 12.3% composted.

Figure 5-1 Evolution of waste treatment options in order to reach 2020 target – Lebanon



Source: See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

The 2020 target volumes are illustrated in Table 5-8 and Figure 5-2 in terms of environmental benefits accruing from the compliance scenario.

Table 5-8 Compliance scenario in terms of waste avoided – Lebanon, 2020

Environmental benefits	2020 Baseline Tons	2020 Target Tons	Net gains Tons
Waste in uncontrolled dumpsite avoided	663,890	295,198	368,692
Waste supplementary composted or recycled	321,237	444,001	122,764

Source: See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

5.3.3 Qualitative assessment of the benefits of reaching the targets

Same as Box 5-1.

5.3.4 Quantitative assessment of the benefits of reaching the targets

The number of employees needed for shifted waste treatment options is assessed as follows:

- An average landfill with a capacity up to 1 million tons requires 1 chief, 4 porters, 1 compactor driver, 1 bulldozer driver, 1 excavator driver, 1 driver, 1 pump operator, 1 maintenance technician, 1 weighing pond operator leading to the creation of 12 jobs;
- The number of employees for a straightforward windrow composting plant of 20,000 tons per year leads to the creation of 5 jobs;
- Job potential in the recycling industry is very diverse, and an average is not estimated. A conservative assumption is that it will not require fewer employees to recycle than to landfill.

When applying these assumptions on the amounts of waste treated in a way diverging from the baseline scenario, the job creation opportunities can be assessed at 91 as illustrated in Table 5-9.

Table 5-9 Job creation from recycling and composting - Lebanon

Job creation through recycling activities	**Waste** Tons	**Job creation** #
Average number of employees to serve a landfill with 1 million tons capacity or 50,000 tons yearly capacity		12
- amount landfilled in the baseline scenario:	1.1	
- amount landfilled in the target compliant scenario:	1.3	
- supplementary yearly capacity	0.2	
Supplementary jobs		53
Average number of employees to yearly recycle 50,000 tons		12
(conservative estimate : recycling generates no less jobs than landfilling)		
- amount recycled in the baseline scenario	0.2	
- amount recycled in the target compliant scenario	0.3	
- supplementary yearly capacity	0.0	
Supplementary jobs		20
Average number of employees to yearly compost 20,000 tons		5
- amount composted in the baseline scenario	0.2	
- amount composted in the target compliant scenario	0.3	
- supplementary yearly capacity	0.0	
Supplementary jobs		18
Total		**91**

Source: See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

5.3.5 Monetary assessment of the benefits of reaching the targets

In case the recycling targets are met, the values generated are listed in Table 5-10, however, composting was not added to the total as compost remain contentious in Lebanon due to the lack of certification of the product. Benefits reach € PPP 40.2 million or LP 44.5 billion equivalent to 0.8% of 2020 GDP.

Table 5-10 Benefits related to the solid waste collection and avoided disposal - Lebanon

Monetary benefit	**Cost lower** € PPP/ton	**Cost upper** € PPP/ton	**Total benefits Lower** € PPP million	**Total benefits Upper** € PPP million	**Total benefits Lower** LP billion	**Total benefits Upper** LP billion	**% of 2020 GDP**
Plastic recycling	92.6	118.5	7.8	10.0	10.1	12.9	
Glass recycling	31.5	33.3	3.0	3.2	3.9	4.1	
Metal recycling	25.9	296.3	1.2	14.2	1.6	18.4	
Paper recycling	44.4	51.9	5.3	6.2	6.9	8.1	
Composting	45.3	66.2	11.9	17.4	15.4	22.6	
Total			**29.3**	**51.0**	**37.9**	**66.0**	**0.8**

Note: recycling costs in Table 5-5 were used.
Source: See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

5.4 Methane emissions

When biodegradable waste is landfilled or dumped, anaerobic conditions may be generated in which it starts to decompose by bacterial activity, generating, among other gases, 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. Methane emissions are still burned in Lebanon, i.e., Nahmeh, Tripoli, Zahleh and Beirut's old Dora dump that is near the coast and that was stabilized in the late 1990s.

5.4.1 Current state

2020 Baseline

The baseline scenario for waste collection and for waste treatment (landfilling) is used.

The sum is made of all waste that, according to these baseline scenarios is either:

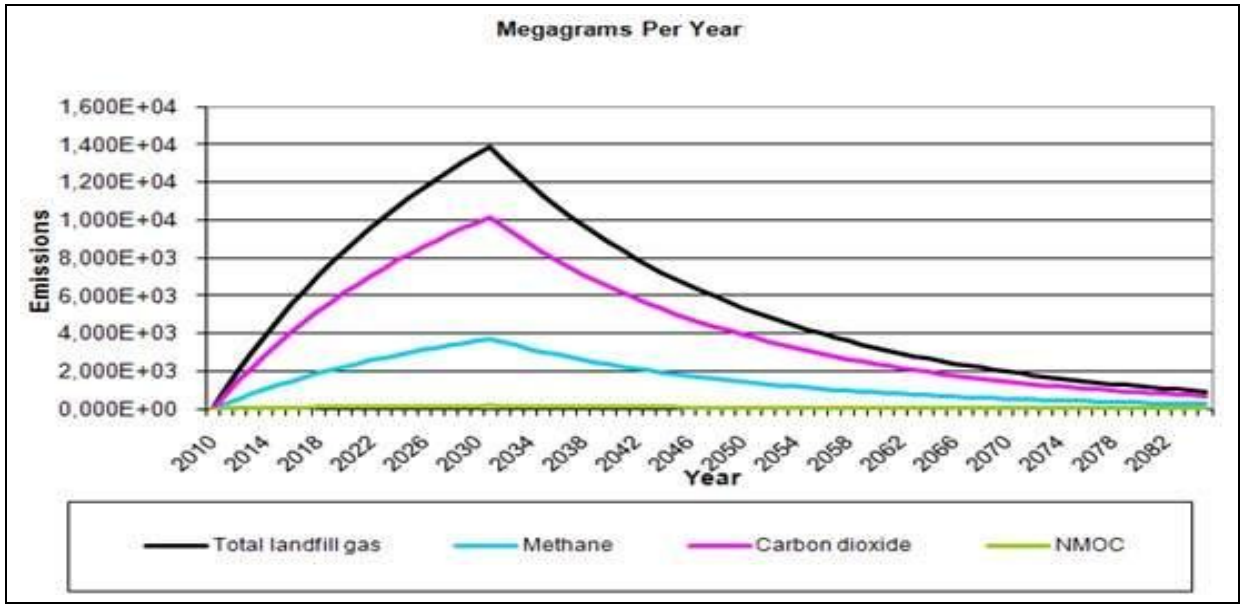
- Not collected and presumed illegally dumped, buried or combusted
- Collected and dumped in non-controlled dumpsites
- Collected and landfilled in controlled landfills

The model of the EPA (United States Environmental Protection Agency) LANDGEM[69] is used to assess the total emissions of landfill gas and of methane from a standardised landfill of 1 million tons with a yearly input of 50,000 tons and a lifetime of 20 years. This can be a proxy for overall landfill emissions. Total methane emissions are assessed at 170.2 million m³ of

69 Landfill Gas Emissions Model (LandGEM) Version 3.02: <www.epa.gov/ttn/catc/products.html#software>.

methane emissions over the whole lifespan of the landfill plus its after-phase. This can be translated into a ratio of 170 m³/ton landfilled solid waste.

Figure 5-3 Methane emissions



Source: EPA website: <www.epa.gov>.

The same ratio is used for dumpsites, although the methano-genesic processes may be different due to different environment conditions and the effect of frequent fire incidents.

The amount of waste treated in these three ways is summed up (Figure 5-3).

2020 Target

The same targets for waste treatment are applied. The methane generation in the baseline scenario are derived from the amounts of waste not being collected, dumped and landfilled. From this quantity the already collected methane is subtracted, the remainder is the figure for methane emissions through waste disposal equivalent to 303.8 million m^3 in 2030 (Table 5-11).

Table 5-11 Methane emissions in the 2020 baseline scenario – Lebanon

Baseline Scenario	**Volume**	**Unit**
Total amount not collected municipal waste in 2020 in the baseline	21,484	tons
Total amount collected municipal waste in 2020 dumped in the baseline	659,353	tons
Total amount collected municipal waste in 2020 landfilled in the baseline	1,106,011	tons
Grand total	**1,786,849**	**tons**
Methane genesis	170	m³/ton
Methane generation for waste disposed of in 2030	303.8	million m³
Methane capture in 2030	0	million m³
Methane emissions for waste disposed in 2030	303.8	million m³

Source: See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

5.4.2 Potential environmental improvements

The methane generation in the target compliant scenario are derived from the amounts of waste not being collected, dumped and landfilled. From this quantity the already collected methane is subtracted, the remainder is the figure for methane emissions through waste disposal (see above).

5.4.3 Qualitative assessment of the benefits of reaching the targets

Same as Box 5-1.

5.4.4 Quantitative assessment of the benefits of reaching the targets

The environmental improvement consists of (Table 5-12):

- methane emissions avoided reaching 82 million m³; and
- methane available as an energy resource reaching 55.4 million m³.

Table 5-12 Methane emissions in the 2020 target compliant scenario – Lebanon

Baseline Scenario	Volume	Unit
Total amount not collected municipal waste in 2020 in the baseline	0	million tons
Total amount collected municipal waste in 2020 dumped in the baseline	0.3	million tons
Total amount collected municipal waste in 2020 landfilled in the baseline	1.3	million tons
Grand total	**1.6**	**million tons**
Methane genesis	170	m³/ton
Methane generation for waste disposed of in 2020	277.2	million m³
20% methane capture in 2020	55.4	million m³
Methane emissions for waste disposed in 2020	221.8	million m³
Methane emissions avoided in 2020: (303.8-221.8 million m^3)	**82.0**	**million m³**
Methane available as an energy resource in 2020	55.4	million m³

Source: See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

5.4.5 Monetary assessment of the benefits of reaching the targets

The social and economic benefits are linked with the value of avoided CO_2 equivalent emissions and the effect of global warming. The carbon values used have a range of € 39 to € 56 per ton for 2020.

Table 5-13 Monetary benefits of meeting improved methane 2020 target – Lebanon

Monetary benefit	GHG avoided emissions 2020 Target	CO_2 value 2020	2020 Target	
	Million ton CO_2 equivalent	€/ton CO_2	€ million	LP billion
Scenario lower bound	1.4	39	54.3	70.3
Scenario upper bound	1.4	56	78.0	101.0
Midpoint			**66.2**	**85.7**
% of 2020 GDP			**0.1**	**0.1**

Source: See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

Methane has a global warming potential (GWP) of 25 for 100 years,[70] which means that one kg methane has the same global warming effect of 25 kg CO_2. The density of methane is 0.68 kg/m³.

An avoided methane emission of 54.4 million m³ corresponds thus with a benefit between € 66.2 million and LP 85.7 million equivalent to 0.1% of 2020 GDP. The results are illustrated in Table 5-3.

70 Forster et al. (2007).

6 BENEFITS OF IMPROVING NATURE RELATED CONDITIONS

6.1 Introduction to nature protection issues

Lebanon covers a total land area of 10,400 km^2 (FAO, 2009); or 10,225 km^2 (World Bank, 2011 citing the National Council for Scientific Research's Remote Sensing Department as territorial waters constitute the difference between the official area of 10,452 km^2 and these 2 land areas). Forests occupy a 13.6% land share (FAO, 2009) or 1,387 km^2. The distribution of some land uses for the year 2009 is shown in Table 6-1.

Table 6-1 Land Use – Lebanon, 2007

Indicator	**Area** (km^2)
Land area	10,225
Inland water	170
Agricultural area	6,871
Arable land	1,442
Permanent crops	1,429
Temporary crops	1,342
Permanent Meadows and Pastures	4,000
Total area equipped for irrigation	1,040
Irrigated area	519 of arable land 686 of permanently cropped land
Forest area	1,387
Other land	1,972

Source: FAO (2009).

This section will cover the following aspects of nature:

- Level of biodiversity protection
- Deforestation levels
- Level of cropland degradation
- Level of rangeland degradation

6.2 Benefits from improving biodiversity protection

Definitions of terms related to biodiversity are listed in Box 6-1.

Box 6-1 Definitions of key terms that apply to this section

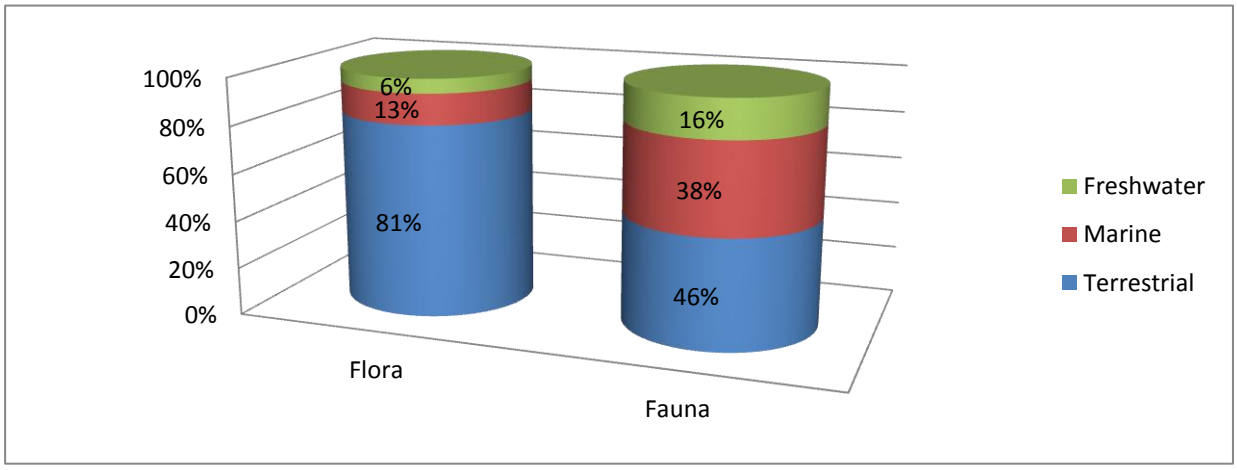
- *Protected areas:* A clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values.
- Protected area management categories also relate to those as defined by IUCN (see Dudley, 2008 for details), namely:
  - 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

Source: Dudley (2008).

6.2.1 Current state

Lebanon enjoys a very rich biodiversity due to its wealth of habitats and varied topography; coastal stretches, high mountains and rivers, and extreme variability in climatic conditions across its landscape. There are 9,119 identified fauna (4,486) and flora species (4,633) in Lebanon (MOA, 1996), mostly in terrestrial ecosystems as illustrated in Figure 6-1.

Figure 6-1 Breakdown of Flora and Fauna Species by Habitat – Lebanon



Source: MOA/UNEP/GEF (1996).

Although it occupies only 0.007% of the earth's land mass, Lebanon harbours 1.1% of the world's plant species (Tohmé and Tohmé, 2007 as cited in MOE, 2009) and 2.6% of the reptile, bird and mammal species (MOE, 2009). Species in the national marine environment represent almost 2.7% of the world's marine species (MOE, 2009). The flora and fauna densities of 0.25 and 0.028 species per km^2 respectively are considered high, especially when compared to neighbouring countries (MOE, 2009).

There are five geomorphological regions in Lebanon (CDR/ECODIT-IAURIF, 1997 and MOE, 2009):

1- Coastal zone: A 250-km stretch of coast which includes the shoreline, continental shelf, the coastal plains and foothills of Mount Lebanon up to 250 m elevations.
2- Mount Lebanon range: A 160-km long, 25-40-km wide mountainous range facing the Mediterranean Sea. It includes middle and high elevation zones above 250 m and peaks at 3,088 m at Qornet El Saouda.
3- The Beqaa Plain: It is a 120-km long, 8-12-km-wide fertile corridor which separates the Mount Lebanon and Anti-Lebanon ranges. It is drained by two perennial rivers – the Litani River and Orontes River.
4- Anti-Lebanon mountain range: It extends across the Lebanese-Syrian borders, and peaks at 2,600 m. The southern parts include Mount Hermon.
5- South Lebanon: It is an elevated plateau that extends from the western foothills of Mount Hermon to a short distance away from the Mediterranean shores of south Lebanon.

The noted terrestrial biodiversity in Lebanon is distributed across seven phyto-association zones as illustrated in Figure 6-2.

The natural landscape of Lebanon is characterised by the gradual change from Mediterranean to continental Mediterranean and sub-desert conditions from west to east (MOE, 2009). The relevant thematic areas for biodiversity in Lebanon as addressed by the NBSAP, 1998 and its addendum (2005) are:

- Terrestrial ecosystems and natural habitat;
- Freshwater environment;
- Marine Environment; and
- Agrobiodiversity.

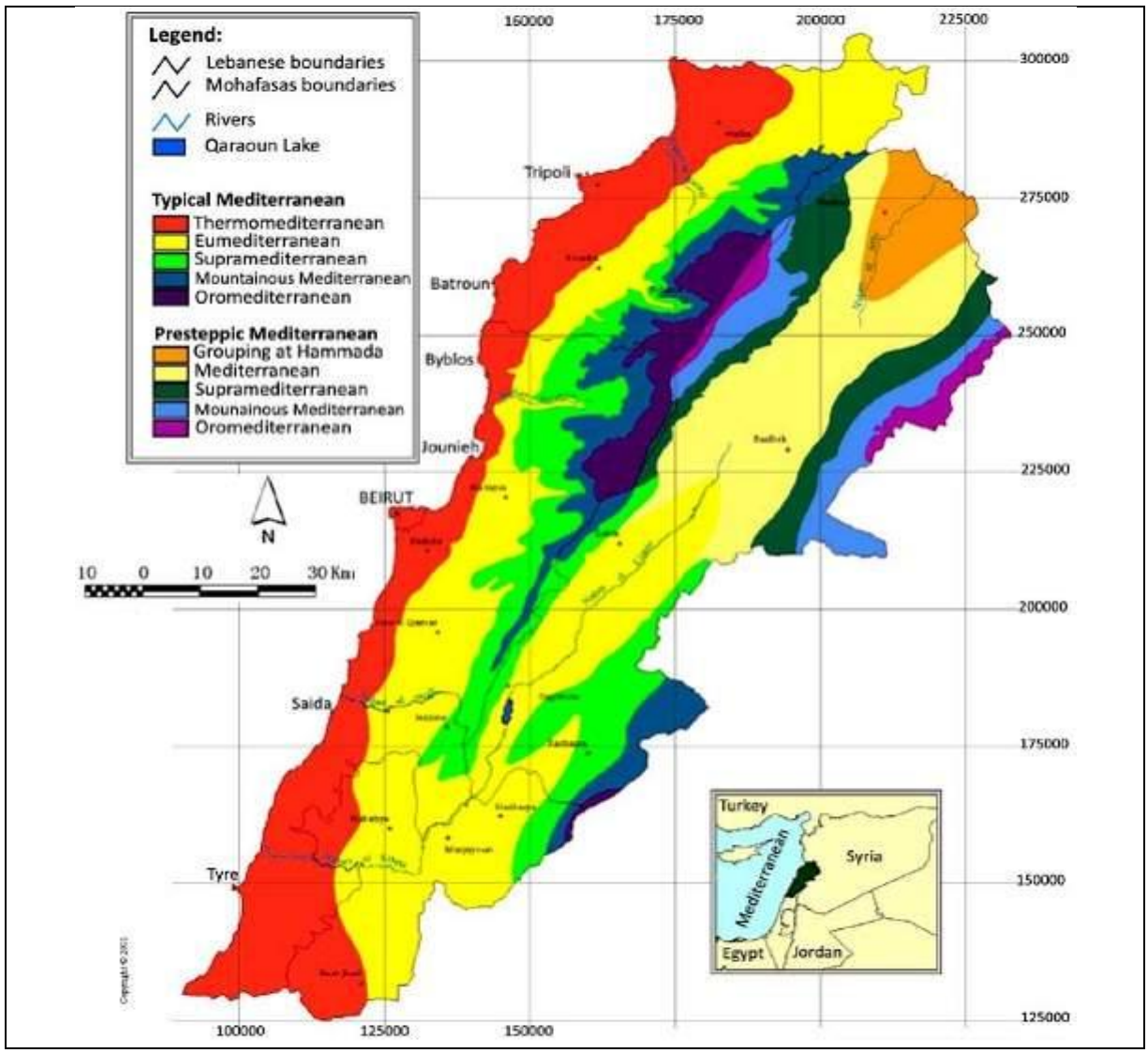
The fourth national report of Lebanon to the Convention on Biological Diversity (MOE, 2009) provides the most recent overview of the status of biodiversity and the threats faced in the four thematic areas.

Legally-established nature reserves in Lebanon occupy about 3% of its total area. Other types of protected areas (PA) include local designations and international designations including IUCN categorisations as illustrated in Table 6-2. There are ten nationally-designated nature reserves under the tutelage of the MOE of which two were given legal protection in 2010: Wadi Al Houjair and Mashaa Chnaniir (MOE, 2011b). An alternative form of protection of areas of natural interest prevails in Lebanon and that is the '*Hima*' under the tutelage of the MOA. There are nine *Himas* – three of which are also designated as nature reserves.

There are also three biosphere reserves, 13 protected forests and 16 protected natural sites/landscapes, with some of these sites boasting international designations: three UNESCO World Heritage Sites of Tyre City, the Cedars of God and Qadisha Valley; three UNESCO Biosphere Reserve of Al Shouf Cedar Reserve, Ammiq Wetland and Jabal Moussa (covering collectively almost 4% of the land area); four Ramsar sites of Tyre Coast, Palm

Islands, Ammiq Wetlands and Ras el Shaqaa; and one UNEP-designated Special Protected Area under the Barcelona Convention of Palm Islands Nature Reserve. Moreover, non-governmental organisations have been especially active in locating and designating the Important Bird Areas (IBAs) with a total of 15 sites identified to date: the nature reserves of Bentael, Horsh Ehden, Palm Islands, Tannourine and Al Shouf Cedar; and other identified IBAs of Aammiq Wetland, Qammouah Park, Ras Baalbeck, Rim Sannine Mountain, Lake Qaraoun, Ramlieh Valley, Anjar-Kfarzabad Hima, Ibl es Saqi Hima, Jabal Moussa and River Beirut Valley.

Figure 6-2 Phyto-association zones and altitudinal levels – Lebanon



Source: Abi Saleh & Safi, 1988, Prepared by Dany Lichaa El-Khoury for GTZ, as cited in MOE/UNDP/GEF 2009.

With regards to PA management, six out of 10 PAs have government-appointed committees (GAC) who oversee the management of the PAs. All other PAs lack management structure and monitoring. The GACs and PA management teams are required to submit management plans to the MOE. The PA management plans form the working plan for the PA management teams, which implement the management plans and suggested projects (Box 6-2). While the technical capacities to implement these plans are generally available, the main constraint facing implementation is that although the MOE has leveraged its budget to improve the

state and management of 6 out of 10 protected areas, its irregular yearly allocations jeopardises their sustainable management.[71]

Table 6-2 Selected important conservation sites and international designation – Lebanon

Legal Status / Site	National Designation		International Designation					
	Nature Reserve	Protection of Sceneries and Natural Sites	UNESCO World Heritage	UNESCO Biosphere Reserve	UNESCO depository of inter-gov. Ramsar Convention	NGO IBAs	UNEP Barcelona Convention Special Protected Area	IUCN Cat.
1. Bentael	GAC							V
2. Horsh Ehden	GAC							V
3. Palm Islands	GAC							V
4. Tannourine	GAC	Hima						V
5. Tyre Coast (Ramsar) and City	GAC		(City)		(Coast)			V
6. Karm Chbat Forest								II
7. Yammounneh		Hima						V
8. Wadi Al Hojaira								V
9. Shnaneer								V
10. Al-Shouf Cedar	GAC	Hima						II
11. Ammiq Wetlands								V
12. Ras Shakaa								V
13. Cedars of God and Qadisha Valley		Hima						III
14. Qammouah Park (Akkar-Dennieh)		Hima						II
15. Ras Baalbeck (semi desert area)								V
16. Rim Sannine mountain								V
17. Qaraoun lake (Beqaa)								V
18. Ramlieh valley (Shouf)								V
19. Anjar - Kfar Zabad		Hima						II
20. Ibl es Saqi (Marjayoun)		Hima						V
21. Beirut River valley		Hima						V
22. Jabal Moussa		Hima						V

Note: the GAC management is overseen by the MOE.
Source: adapted from METAP (2009a) based on the following websites: MOE <www.moe.gov.lb>; UNESCO <www.unesco.org>; Ramsar <www.ramsar.org>; and IBA <www.birdlife.org>.

The PA designation and therefore management categories of protected areas were not consistently defined. An effort was made in 2005 at a national level to devise a category system based on the UNEP and IUCN classification system (Khater, NAP, 2006). Although the IUCN categorisation listed in Table 6-2 remains tentative, the proposed national PA category system acknowledges four categories with clear guidelines for designation and defined management bodies:

(i) National Park (IUCN Category II);

(ii) Natural Monument (IUCN Category III);

(iii) Habitat/Species Management Area (IUCN Category IV); and

(iv) Protected Landscapes/Seascapes (IUCN Category V).

71 These transfers made to protected areas fall under Article 14-2-1 (transfers to non-profit organizations) in the budget and this irregularity could result from budgetary constraints and is characteristic of transfers to non-profit organizations allocated to all Ministries and does not target the MOE as such.

Legislative texts have been prepared to legally endorse the suggested categories, upon which the current PAs would need to be reclassified according to one of the four categories (USAID/Ecodit, 2009).

The recently published State of the Environment Report (MOE, 2010b) highlights the need to develop indicators on the effectiveness of conservation activities, including PA management, to assist the country in assessing progress towards meeting global biodiversity targets.

Box 6-2 GAC versus hima system of management - Lebanon

For six of the ten nature reserves under the mandate of the MOE, the committee is referred to as the GAC. GACs are composed of voluntary representative members of municipalities that have borders adjacent to the PA as well as relevant line ministries, NGOs, CBOs, academia, national experts, etc. The GAC members are designated by the Minister of Environment after consultation with local stakeholders whereas the draft Nature Reserves law will replace the GAC by the Appointed Protected Area Committee where representatives are suggested by the stakeholders and endorsed by the MOE.

GACs, whose mandate was detailed in a Ministerial decision, have a main function to oversee the management of the PA based on a management plan that is developed and agreed upon with the MOE. GACs are not completely independent in their decision making process as prior approvals are required by the MOE on all aspects related to PA management. Nature reserve supervision and oversight functions are performed by the GACs whereas management teams contracted by GACs are responsible for day-to-day activities.

The GAC structure is a step forward towards decentralized management. It helps take into consideration, within certain limitations, the requirements of the local populations in the management of the PAs. The structure has however a lot of leeway for improvement. There is no representation of site users such as, where relevant, farmers, fishermen, bee keepers, etc. NGO representation is restricted to environmental organizations where in all cases NGOs focusing on socio-economic themes are not represented although they can have great added value. The leverage of GAC decision making is bound by the management plan, which in the process of its development, does not necessarily involve all stakeholders. For instance, the stakeholder group for the first management plans drafted for PAs in Lebanon considered the Municipalities, the MOE and few NGOs as the only stakeholders of the site. A progressively wider but not complete inclusion was achieved during management implementation and in the development of other plans.

Conversely, the Society for the Protection of Nature Lebanon introduced the hima system for the conservation the Kfarzabad and Ibl el Saqi wetlands. The hima system is a bottom up community-based participatory approach to protect areas with the support of municipal decision-making. It is an old traditional system for the management of mainly land grazing. The hima system has not yet been adopted by the MOE and the decision rests solely with municipality powers and can be revoked arbitrarily by municipal councils. The management of PAs moved from a complete top down approach towards the introduction of some elements of a participatory approach. The latest trends suggest a biodiversity conservation mainstreaming in economic sectors and/or national policies.

Note: Hima is protected area; Hima system of management is a traditional participatory management system.
Source: METAP (2009a).

There is no national biodiversity database and no national biodiversity monitoring programme (MOE, 2009). Data from international reports[72] show that there are no threatened higher plant species, 10 threatened mammal species, 6 threatened bird species and 15 threatened fish species. The GEF benefits index for biodiversity,[73] which measures the potential global benefits that can be realised from biodiversity related activities in a country, is 0.17 for Lebanon. The number of species identified nationally as rare/endemic or nationally important varies between 92 (MOE, 2005) and 119 (Kew and LARI, 200-).

72 IUCN website: <www.iucn.org>.

73 GEF benefits index for biodiversity is a composite index of relative biodiversity potential for each country based on the species represented in each country, their threat status, and the diversity of habitat types in each country. The index has been normalized so that values run from 0 (no biodiversity potential) to 100 (maximum biodiversity potential).

There are a total of 15 (Table 6-2) recognised IBAs in Lebanon (BirdLife International: <www.birdlife.org>), 11 are IBAs of varying global importance, three are IBAs of Middle Eastern importance, and one which is both of global and Middle Eastern importance (the Palm Islands Nature Reserve). Five of the IBAs are already protected by law: Horsh Ehden Nature Reserve, Palm Islands Nature Reserve, Bentael Forest Reserve, Tannourine Cedar Forest Reserve and Al-Shouf Cedar Forest Reserve.

Box 6-3 Quarries – Lebanon

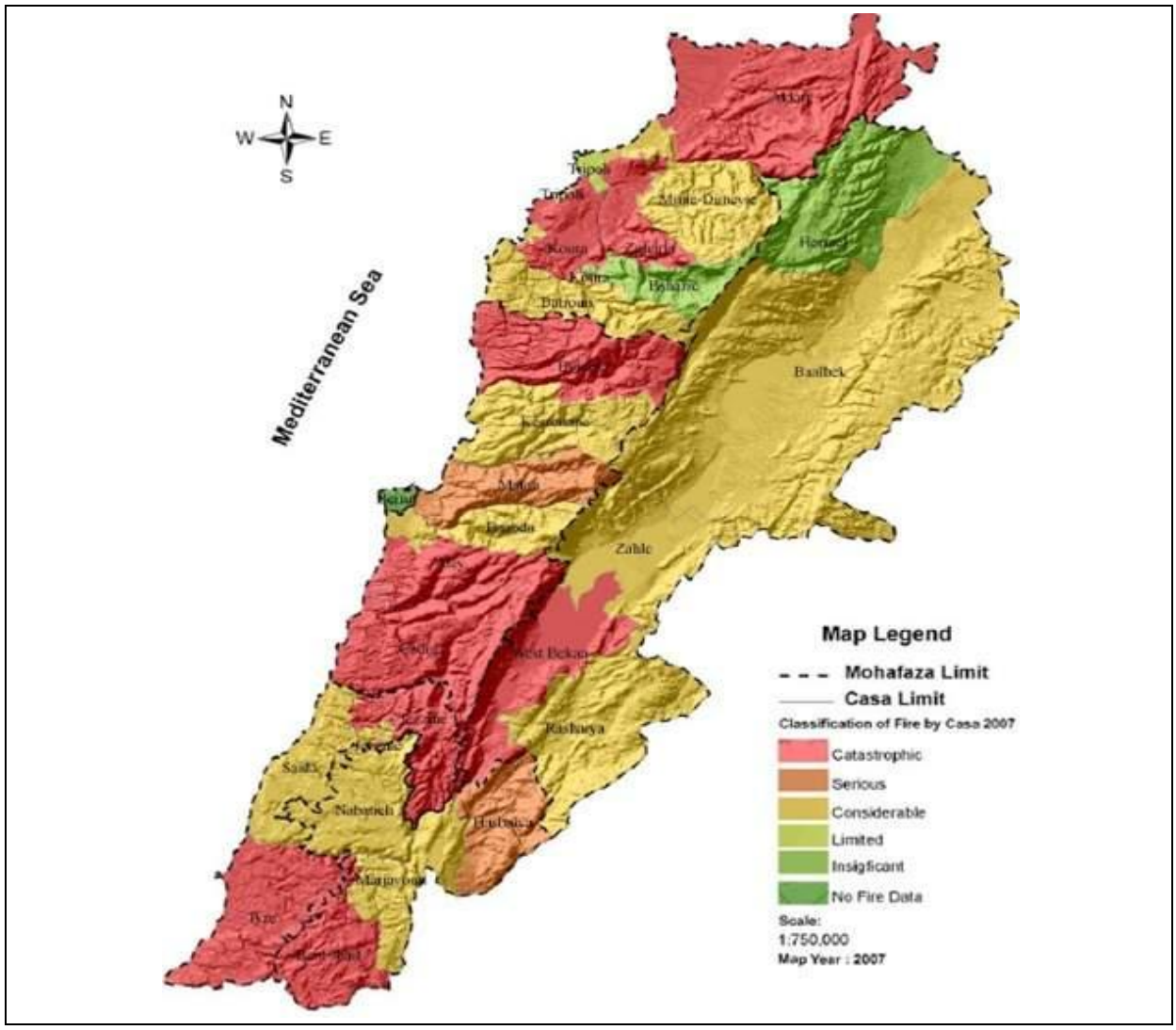
Active and abandoned quarries in Lebanon are a major eyesore in the Lebanese mountainous landscape. Their impacts go beyond degraded scenery to cause landscape fragmentation, loss of biodiversity and decreased quantity and quality of water resources. Between 1996 and 2005 the number of quarries increased from 711 to 1,278, and the quarried land area increased from 2,875 to 5,283 ha. Recent remote sensing data (2005) showed that 21.5% of quarries were distributed on forested land and arable land while 32.4% were detected on scrubland and grassland and 3.2% of quarries were distributed inside urban zones. Land degradation resulting from mismanagement of quarried sites affects the ecosystem and water balance in the watersheds leading to soil erosion and landslides. Quarries, particularly those on steep slopes with unstable rocks, increase landslides and other mass movements with consequent destruction of natural habitats and biodiversity. Removing the topmost soil layer and surface rock material multiplies the vulnerability of groundwater contamination due to karst features of hard limestone and the high infiltration rate of disturbed sands.

Source: Adapted from Darwish et al. (2008).

The main threats to Lebanon's biodiversity originate from human activities. Habitat loss and degradation, invasive alien species, flow modification, harvesting, climate change, pollution, genetically modified organisms (GMOs) and hybridisation are the main pressures on biodiversity in Lebanon. Habitat loss is a major source of pressure resulting from uncontrolled urban expansion, destruction and/or permanent alteration of the coastal zone, extension of agricultural areas, quarries (Box 6-3) and sand removal, destruction of sea bed habitats through pollution and forest fires (MOE, 2009). Overexploitation, overgrazing, drainage, deforestation and poor management practices are leading to habitat degradation. Uncontrolled import of exotic species, the import of non-native donated forestry plants, and the marine species migrating from the Red Sea into the Mediterranean Sea cause the invasiveness of the alien species. Flow modification and pollution of rivers have resulted in an altered ecology and it is not clear if the damages are reversible. While harvesting of edible, aromatic and medicinal plants has been traditionally practiced in the rural areas of Lebanon, this activity is not controlled and overharvesting could result in a decline in the natural population of these plants. Unsustainable hunting and fishing practices are also a concern posing a threat to the regeneration of wild species. Climate change is expected to negatively influence biodiversity in Lebanon through changes in the water regime, temperature changes and the expected shift of bioclimatic zones to higher altitudes. GMOs and hybridisation of species could potentially be problematic given the loose biosafety legislation and little exercised control (MOE, 2009).

Poorly regulated quarrying and forest fires are considered a major threat to terrestrial biodiversity in Lebanon. Whereas quarried land area increased from 2,875 in 1996 to 5,283 ha in 2005 due to the construction boom (Box 6-3), forest fires have increased in frequency and intensity over the decade due notably to climate change. Reported forest fires and forested lands affected by fires between 2004 and 2009 are illustrated in Table 6-3 while the most damaging fires of 2007 are plotted in Figure 6-3.

Figure 6-3 Forest fires – Lebanon, 2007



Source: MOE (2007).

Table 6-3 Forest fires – Lebanon, 2004-09

Forest Fire	2004	2005	2006	2007	2008	2009
Number	119	117	144	275	426	281
Area affected (ha)	585.3	440.0	874.6	4,031.0	1,860.5	2,644.0

Source: data provided by the MOE and compiled by CAS.

Threats to freshwater biodiversity and marine biodiversity are mainly from pollution and the increasing demand of a growing population for freshwater sources. Agro-biodiversity is also threatened due to habitat loss and degradation, as well as the misuse of chemical fertilisers and pesticides.

In Lebanon, the biodiversity resources and ecosystem services have not been valued yet, due to knowledge gaps about the direct and indirect biodiversity services and ecosystem functions (Sattout and Abboud, 2007 as cited in MOE, 2009). The economic value of different forest ecosystems in Lebanon was estimated at about € 89.9 million, where the economic

value of medicinal and aromatic plants was estimated at € 16.1 million and that of honey production at € 9.2 million (Sattout et al., 2005 as cited in MOE, 2009). The economic value of legal game birds was estimated at € 9.2 million in terms of meat and € 4.5 million in terms of licenses value (Ramadan-Jaradi, 2008 as cited in MOE, 2009).

6.2.2 Potential environmental improvements

2020 Baseline

The specific focus of the benefits assessment on biodiversity will be on the comparison of the 2020 target to the 2008 reference year. In other words, the baseline is not considered here a critical issue for the assessment of the benefits.

2020 Target

The Convention on Biological Diversity (CBD) Strategic Plan for 2011-2020 includes a target for protected areas (see Box 6-4) that at least 17% of terrestrial and inland water, and 10% of coastal and marine areas (if applicable), are conserved through effective management practices. This will therefore be used as the target for this study.

This is the CBD target for global PA coverage to which the ENP countries have signed up to in Nagoya 2010.

Box 6-4 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% of terrestrial and inland water, and 10% 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: CBD website: <www.cbd.org>.

Lebanon adopted in its addendum to the NBSAP in 2005 the global biodiversity 2010 targets. While the country did not establish its own national goals to achieve the relevant goals and objectives of the Strategic Plan and the 2010 targets, it has, until 2009, progressed towards these goals and objectives through several projects which have achieved their objectives of conserving and protecting biodiversity (MOE, 2009).

The environmental improvement is based on the increase in PA designation if the CBD Strategic Plant target and/or national target are achieved.

6.2.3 Qualitative assessment of the benefits of reaching the targets

An overview of key benefits derived from reducing deforestation in Lebanon is illustrated in Box 6-5.

Benefits from the setting up of PAs include an increase in the number of touristic activities carried out in these areas. Data from three nature reserves indicate that the total number of tourists is around 50,000 per year.[74]

Box 6-5 Benefits of improving biodiversity protection - Lebanon	
Health benefits	Health benefits associated with better nature and biodiversity protection are manifested in the increase in green space for recreation and relaxation etc., with associated mental and physical health benefits. Health benefits from clean air and water from intact ecosystems are also worthy of consideration.
Environmental benefits	The following environmental benefits from improving biodiversity protection could potentially be achieved: – Safeguarding species, especially threatened species and species that occur in internationally important numbers, – Sustainable use of natural resources (vegetation, water, soils etc.), – Maintaining and enhancing ecosystem services (water storage/purification, carbon storage, flood control etc.), and – Increased resilience to climate change/adaptation
Economic benefits	The economic benefits from improving the level of biodiversity protection and increasing the share of protected area are translated in: – Increased opportunities for eco-tourism, including revenue generation from tourism (entrance fees etc.) and job opportunities (paid or voluntary), – Income generation from associated businesses – hotel, catering, B&B, recreation (mountain biking, walking, climbing etc.), and – Support for regional products (food, game etc.).
Social benefits	The benefits from a social point of view could be the: – Amenity and recreation facilities, – Opportunities for education and research, – Increased public awareness of environmental issues, and – Enhancement of social values (e.g., iconic species, traditional lifestyles, valued landscapes and maintenance of 'a sense of place').

Source: See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

6.2.4 Quantitative assessment of the benefits of reaching the targets

The quantitative benefits from increased protection of biodiversity cannot be easily measured, since the benefits are highly dependent on the types of ecosystems that will be given added protection and their current status and biodiversity importance and threats.

6.2.5 Monetary assessment of the benefits of reaching the targets

The available studies (Merlo and Croitoru, 2005, Sattout et al., 2005 and Ramadan-Jaradi, 2008 as cited in MOE, 2009) provide estimates of the current values of existing forest and natural resources. For instance, Merlo and Croitoru (2005) calculated the total economic value (TEV) or the direct and indirect benefits from forests in Lebanon. The TEV was estimated at US$ 161 per ha, with non-wood forest products offering the largest share value at US$ 165 per ha. The recreational value of forests was estimated at only US$ 3 per ha, grazing at US$ 9 per ha and hunting at US$ 114 per ha. Option, bequest and existence values were estimated collectively at US$ 8 per ha. Values for watershed protection were not available. Values were reported in 2007 US dollars.

74 MOE website: <www.moe.gov.lb>.

The main limitation to providing a monetary assessment of the benefits of improving the ecosystem service provision and ultimately the benefits from improving biodiversity protection lies in performing a costly and complicated survey to derive the state preference of the target population that benefit from these services.

In Lebanon, the biodiversity resources and ecosystem services have not been valued yet, due to knowledge gaps about the direct and indirect biodiversity services and ecosystem functions (Sattout and Abboud, 2007 as cited in MOE, 2009). The total economic value of Lebanese forests in Lebanon was estimated at € 93.7 million or US$ 131.5 million in 2001 currency values, where the economic value of medicinal and aromatic plants was estimated at € 16.65 million (US$ 23.5 million) and that of honey production at €12.15 million (US$ 13.5 million) (Sattout et al., 2005). The economic value of legal game birds was estimated at US$ 13.5 million in terms of meat and US$ 6.6 million in terms of licenses value (Ramadan-Jaradi, 2008 as cited in MOE, 2009).

6.3 Benefits from reducing deforestation

The benefits assessment on this subtheme of 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 (Box 6-6).

This parameter measures the annual change in the area of forested land. Change is measured either as number of hectares or as area percentage increase or decrease in forested land. 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 global prominence, which will lead to increasing market/payments for avoided carbon emissions from deforestation and forest degradation. The quantitative and the monetary assessment focus on these benefits, i.e., on the value of carbon stored in forest biomass, as this is perceived to be a figure that is easy to understand and communicate to policy makers and the wider public. The quantitative assessment focuses on benefits in terms of the quantity of carbon captured by the existing forests, 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 forests today and in the future (potential for sequestration) has been estimated.

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, and provision of fresh water, soil protection, cultural heritage values and tourism opportunities – leading to significant environmental, health, social and economic benefits.

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.

For carbon values, the focus is on stock values, and the marginal value of avoiding potential losses where deforestation is not currently an issue, but where it will be important to protect and well-manage the existing forests in order not to lose its existing value. Overall, the carbon values are estimated with a relatively simple procedure. 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 6-6 Definitions of key terms that apply to this section

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

Source: See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

6.3.1 Current State

About 13.4% of Lebanon is forested or about 137,000 ha of a total land area of 1,023,000 ha according to the FAO (FAO, 2011a).

Forests' designated functions are mostly for multiple use (66%) and for protection of soil and water (25%), while 3% is for biodiversity protection with production at 6% (Table 6-4).

Table 6-4 Forest primary designated functions – Lebanon

Function	Production	Protection of soil and water	Conservation of biodiversity	Social services	Multiple use	Other	None or unknown
Area (%)	6	25	3	0	66	0	0

Source: based on (FAO, 2011a).

Contrary to popular belief, the numbers indicate that there is no net deforestation in Lebanon. Between 1990 and 2010 Lebanon gained 4.6% or 6,000 ha. There was an average gain of 0.25% per annum, or 6,000 ha. This "net" picture can hide the fact that deforestation and forest fragmentation occurred in some areas and afforestation took place in others, so deforestation should not be seen as a non-issue, nor not a risk; deforestation looms as a

threat if urban encroachment, increases in forest fires and insufficient protection of existing stocks continue (Table 6-5 and Table 6-6).

Table 6-5 Trend in total net forest cover - Lebanon

Year	1990	2000	2010
Total net forest cover (ha)	131,000	131,000	137,000

Source: FAO website: <www.fao.org/docrep/013/i2000e/i2000e.pdf> (FAO, 2011a).

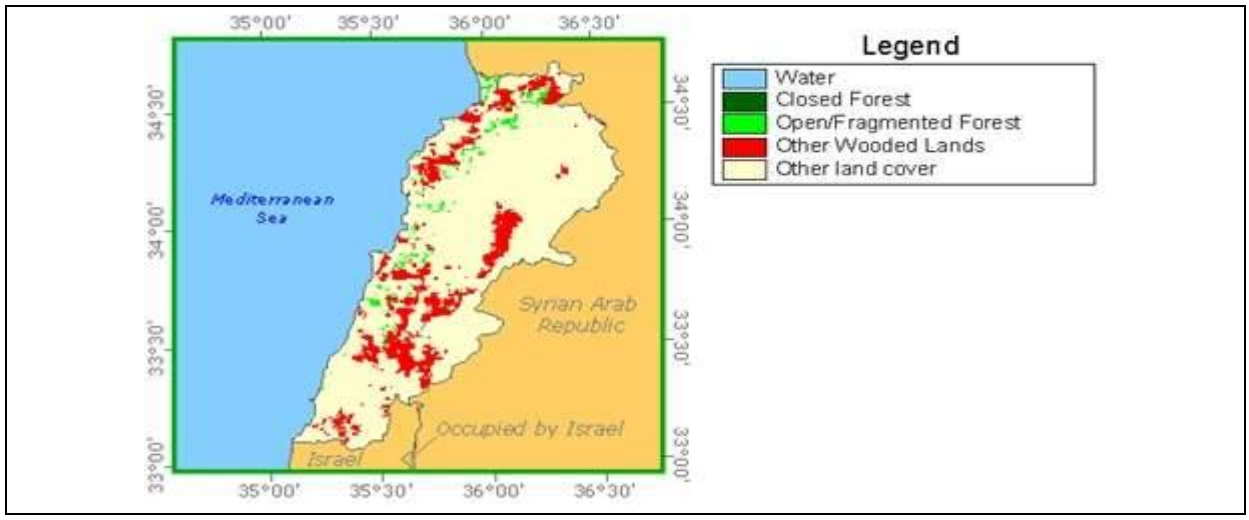
Table 6-6 Forest cover annual change rate - Lebanon

Year	1990-2000	2000-2010	1990-2010
Annual Change Rate (%)	0	0.4	0.23

Source: Authors calculations based on FAO website: <www.fao.org/docrep/013/i2000e/i2000e.pdf> (FAO, 2011a.)

Measuring the total rate of habitat conversion (defined as change in forest area plus change in woodland area minus net plantation expansion) for the 1990-2010 intervals, Lebanon gained 0.23% per year.

Figure 6-4 Forest cover map – Lebanon, 2000



Source: website: <rainforests.mongabay.com/deforestation/2000/lebanon.htm>

6.3.2 Potential environmental improvements

In order to assess the benefits related to forestry, an ENP-wide *no net loss by 2020* target was set (to facilitate cross ENP country comparison). This ENP-wide target calls for reducing the annual incremental reduction of the current deforestation rate to 0% by 2020.

Deforestation, however, is not currently an issue in Lebanon as there has been a net albeit small gain in forest cover (2010 data from (FAO, 2011a)). Implementing the study target therefore will not lead to additional environmental improvements in terms of forest size. The assessment will therefore rather focus on the existing benefits provided by forested areas. What the analysis will highlight is that it will be important not to degrade or reduce the size of the existing forest in order not to lose the current benefits.

The benefits in terms of carbon currently stored, and its equivalent monetary value, are assessed in the next chapter.

As noted above, the ENP-wide *halting deforestation target* will have no implications for Lebanon. The historical trend, if continued to 2020 would rather suggest a growth in forest cover of 3,000 ha, or a 2.3% rise in area coverage over the next decade.

6.3.3 Qualitative assessment of the benefits of reaching the targets

An overview of key benefits derived from maintaining a negative net deforestation rate in Lebanon is illustrated in Box 6-7.

Box 6-7 Benefits of reducing deforestation	
Health benefits	Forests can promote health and well-being through their use for recreation and relaxation. Obtaining evidence for this benefit is not straightforward.
Environmental benefits	Provision of habitat for animal species diversity and ecosystem regulating services such as carbon storage, soil and water conservation, flood or avalanche control, slowing the rate of desertification, and coastal protection.
Economic benefits	Forests give rise to a number of provisioning services that generate wealth. Specific examples include the provision of timber, fibre, non-wood forest products such as gums/resins, honey/wax, dyeing and tanning products, bushmeat and other foods, and medicines. Economic benefits may also 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. Well-managed forests can also attract visitors and hence increase revenues from tourism/recreation. Management of forest for amenity provision or biodiversity conservation may also generate employment opportunities.
Social benefits	Benefits include provision of amenity for recreation, education, tourism, cultural and spiritual heritage.

Source: See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

6.3.4 Quantitative assessment of the benefits of reaching the targets

Lebanon's forests contain 2 million tons of carbon in living forest biomass, according to 2010 estimates (Table 6-7 and Table 6-8), which is equivalent to 7 million tons of CO_2. According to 2000 estimates, each hectare of forest stores on average 13 tons of carbon,[75] i.e., 47. 7 tons of CO_2 (FAO, 2011a). Note that significant levels of carbon are also found in the soil and litter, so the carbon values used here should be seen as a conservative figure.

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 increased reflection of heat into the atmosphere in an area heavily forested, than on other lands that are more open and soil covered. Another effect can be due to forests' 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 burned, during forest fires or the clearing of forest land (source of carbon emissions).

According to the FAO 2010c report, the world's forests store more than 650 billion tons of carbon, 44% in the biomass, 11% in dead wood and litter, and 45% in the soil. However, this assessment is limited to what is stored in biomass.

75 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.

Further to this *The Economics of Ecosystems and Biodiversity* (TEEB) study shows that halting 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 the huge range of services and goods they provide to local people and the wider community (TEEB, 2009; TEEB 2010; and TEEB 2011).

Table 6-7 Comparative assessment for carbon stored under both scenarios - Lebanon

Year	2010	BAU: 2020 – continued trend	Target 2020: halting deforestation trend in 2020	Net saving from halting deforestation	Continued historic trend: Net gains relative to 2010
CO_2 stored (million tons)	7	7	7	N.A.	0.1

Source: FAO website: <rainforests.mongabay.com/deforestation/2000/lebanon.htm> adapted from (FAO, 2011a).

Table 6-8 Carbon stock in living forest biomass – Lebanon

Year	1990	2000	2005	2010
Carbon stock in living forest biomass (million tons C)	2	2	2	2
Carbon stock in living forest biomass (million tons CO_2)	7	7	7	7
Carbon stock in living forest biomass (per ha in tons)	13	13	13	13
CO_2 stock equivalent in living forest biomass (per ha in tons)	48	48	48	48

Source: FAO website: <rainforests.mongabay.com/deforestation/2000/Lebanon.htm> adapted from (FAO, 2011a).

According to 2000 estimates, and as mentioned earlier, each hectare of forest stores on average 13 tons of carbon, i.e., 47.67 tons of CO_2 (FAO, 2011a). Accordingly, in 2010 Lebanon's forests stored about 2 million tons of carbon in living forest biomass (Table 6-7 and Table 6-8). It will be crucial that no deforestation or degradation takes place in the future in order not to lose the benefits currently provided in terms of carbon storage.

6.3.5 Monetary assessment of the benefits of reaching the targets

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

Assuming a value of CO_2 of € 17.2 per ton (low) and € 32 per ton (high) in 2010, the value of the carbon currently stored by the Lebanese forests ranges between € 112 and 209 million. This is the value of the carbon stored in the living biomass today.

If no deforestation or degradation takes place by 2020, and assuming a carbon value of € 39 per ton (low) and € 56 per ton (high), in 2020 the carbon stored (in the current stock) will be worth between € 255 and 355 million and between € 6 and 8 million more if stock continues equivalent to 0.01% of 2020 GDP (Table 6-9). Note that this is only the carbon value and does not present the wide range of other ecosystem services.

It is also useful to underline that the above values are stock values and not an annual value of carbon sequestered,[76] 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.

Table 6-9 Estimated monetary value of carbon storage – Lebanon, 2010 and 2020

Scenario	2010 Value		2020 Target				
	Unit value	Total value	Unit value	Total value If forest carbon stays at 2010 levels	Total value "Target": If deforestation halted by 2020 – value of halting deforestation	Total value Baseline: if trend continues (If deforestation not halted / if afforestation continues)	Net Value of stock gain 2010 to 2020
	€/t$C0_2$	€ million	€/tC02	€ million	€ million	€ million	€ million
Low estimate	17.2	112	39	255	N.A.	260	6
High estimate	32	209	56	366	N.A.	374	8
Midpoint						**317**	**7**
% of 2020 GDP							**0.01**

Source: See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

6.4 Benefits from reducing cropland degradation

Agricultural cropland degradation is widespread in many countries. This section assesses the benefits of a reversal of cropland degradation or, in other words, an improvement in cropland quality. A target for improvement in cropland quality to be achieved by year 2020 is specified, direct and indirect benefits of cropland improvements are discussed qualitatively, and direct benefits in terms of increased value of crop production are quantitatively assessed (Box 6-8).

Box 6-8 Definitions of key terms used in this section

- *Cropland:* Land used for cultivation of agricultural crops.
- *Area harvested:* Hectares of cropland multiplied by the number of harvests per year.
- *Crop yields:* Tons of crop harvested per hectare of area harvested.
- *Crop production:* Tons of crop 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.
- *Cropland quality:* Here defined as those characteristics and properties of cropland that affect crop

76 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.

yield. Cropland quality is impaired by cropland degradation and potentially improved by improved cropland management.
- *Cropland degradation:* Inter-temporal changes in properties of cropland 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 cropland management:* Here defined as practices that reduce, prevent, or reverse cropland degradation and preserve or improve cropland quality with positive impacts on crop yield.

Source: See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

6.4.1 Current state

Agriculture share of GDP in Lebanon was 5.3% in 2008 (World Bank, 2010). Area harvested was 275,000 ha in 2008. Cereals constituted 70,000 ha and other crops about 205,000ha.[77] Much of the agricultural cropland in Lebanon 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).[78] 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, all land in Lebanon suffers from some degree of human induced degradation (Table 6-10). The main identified type of human induced land degradation is water erosion largely caused by overgrazing and deforestation.

A disadvantage of the GLASOD data is that they date back more than 20 years. They may therefore represent an underestimate of land degradation today. Advantages of the data are that they provide a basis for multi-country economic assessments, and that economic assessments are simplified by the data providing land categories that reflect an aggregate of various forms of degradation.[79] It is therefore not necessary to undertake an economic assessment of each type of soil degradation (erosion, salinity, nutrient losses, and other degraded chemical and physical properties of the soil).

Table 6-10 Extent of human induced land degradation - Lebanon

Degradation	**Land area degraded** (% of national territory)	**Population distribution**
None	0%	0%
Light	69%	69%
Moderate	6%	6%
Severe	25%	25%
Very Severe	0%	0%
Causes	Overgrazing - Deforestation	
Type	Water erosion	

Source: FAO (2000).

77 Area harvested is estimated based on linear trends using FAO reported data from 1995-2008 due to annual fluctuations in area harvested (FAO 2011).

78 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).

79 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.

6.4.2 Potential environmental improvements

2020 Target

The target for which benefits are assessed in this study is an improvement in cropland 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 cropland quality as stipulated by the target is achievable through improved cropland management practices that reduce or halt on-farm loss of top soil from erosion, reduce soil salinity, partially or 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 without 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 6-11 using a "low", "medium" and "high" scenario.[80]
- 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.

Table 6-11 Assumptions of current crop yield reductions on degraded land - Lebanon

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: See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

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

2020 Baseline

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

Projections in real crop prices to year 2020 must also be made in order to estimate the monetary benefit of improvement in cropland quality.[81]

80 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).

Table 6-12 Projected baseline crop production and production value - Lebanon, 2008-2020

Crop production	Cereals	Other crops
Annual change in crop production	+3.1%	-0.9%
Annual change in real crop prices	+4.0%	+3.0%

Source: See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

Baseline assumptions are presented in Table 6-12.

Projected annual crop production from 2008 to 2020 is based on linear trends in production of cereals and other crops in Lebanon from 1990 to 2008 using data from FAO (FAO, 2011a,b). Projected production reflects changes in both area harvested and crop yield.

Crop prices may be expected to increase at a faster rate to 2020 than prices of other goods and services in the economy. The world food price index increased by 33% and the FAO world cereals price index increased by 31% from the 2007-2010 average index value to the January-February 2011 average index value (FAO, 2011a,b). However, the large price increases of cereals and foods observed during 2006-2008 and again in 2010 are likely to be offset 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 year and the real prices of other crops at a rate of 3% 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 in Lebanon for other crops.[82]

Improvements achieved by reaching the targets

The improvements of reaching the target by 2020 are the difference between cropland quality with no change in cropland management practices and cropland 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 cropland management practices may also be expected to have many other benefits (Box 6-9).

The GLASOD data do not map crop areas harvested by the categories of land degradation in Table 610. Assumptions about distribution of crop areas harvested must therefore be made. Two distribution options are used here:

1. Crop areas harvested are distributed in proportion to land area in each land degradation category, e.g., 10% of areas harvested in Lebanon are on moderately degraded land (see Table 611).

2. Crop areas harvested are distributed in proportion to population distribution across the land degradation categories, e.g., 5% of the population occupies moderately degraded land (see Table 6-12).

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

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

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.

Using the data in Table 6-11, Table 6-12 and Table 6-13 presents estimates of yield increase from meeting the target in 2020 based on the two distributions of crop areas harvested. "Low", "medium" and "high" refer to the scenarios of yield losses from land degradation.

Table 6-13 Estimates of yield increase from meeting the 2020 target - Lebanon

Scenario	Land area distribution	Population distribution	Mean value
Low	4%	4%	4%
Medium	5%	5%	5%
High	6%	6%	6%

Source: See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

6.4.3 Qualitative assessment of the benefits of reaching the targets

Improvement in cropland management resulting in improved cropland quality and reversal of cropland degradation has many direct and indirect benefits including health, environmental, economic and social benefits. 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 Box 6-9 (e.g., see also CDE, 2009).

Box 6-9 Benefits of improved cropland 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 fertiliser 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: o causes turbidity in the water that limits light penetration and prohibits healthy plant growth on the river bed. o can cover much of a river bed with a blanket of silt that suffocates life. o 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 cropland 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 cropland 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: See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

6.4.4 Quantitative assessment of the benefits of reaching the targets

Many of the benefits of improved cropland 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 cropland management. The economic benefits of reduced dam and reservoir sedimentation are especially important in water scarce regions. The social benefits of improved recreational values from reduced agro-chemical pollution of water resources are reflected in the BA 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% by 2020 are estimated based on the yield increases in Table 6-13. The yield increases are multiplied by the estimated value of crop production in 2020. This provides the estimated value of the extra tons of crop production as a result of reducing land degradation and is the 2020 annual benefit of meeting the target.

6.4.5 Monetary assessment of the benefits of reaching the targets

The projected real market value of total crop production in year 2020 is LP 2,960 billion. The annual benefits, i.e., the estimated value of the extra tons of crop production, in year 2020 of achieving the target amount to 4-6% of this value, or LP 125-181 billion (€ PPP 97-140 million). This is equivalent to 0.20-0.29% of 2020 GDP. All figures are in 2008 € PPP and LP 2008 (Table 6-14).

Table 6-14 Estimated annual benefits in 2020 of meeting the target - Lebanon

Crop value	Low	Medium	High
Value of increased crop yields (LP billion)	125	**153**	181
Value of increased crop yields (€ PPP million)	97	**118**	140
Value of increased crop yields (% of 2020 GDP)		**0.25**	

Note: Mean value of estimated yield increases in Table 6-11 is applied.
Source: See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

6.5 Benefits from reducing rangeland degradation

The total area of permanent meadows and pastures, as estimated by FAO for 2008 is 400,000 ha or 39% of the total land area of Lebanon (Box 6-10).[83] A previous estimation

83 FAO website: <www.fao.org>.

(FAO, 1980) had put the figure of rangelands at 52% of the total area. The Beqaa Valley accounts for 40% of Lebanon's rangelands (Hamadeh et al., 1996). Marginal lands in the semi-arid zones are commonly used as grazing grounds; however, these are increasingly used in crop production and are thus becoming less available to livestock production (Hamadeh et al., 1999). Small ruminant production in Lebanon is largely extensive and is characterised by low productivity. Local breeds of sheep and goats number 330,000 and 400,000 heads[84] for 2008, and they are adapted to the scarce vegetation and arid conditions of the Lebanese drylands. Pasture rents represent major input costs for livestock farmers in the extensive production systems such as the transhumant and semi-nomadic systems, constituting a 15 to 33% share of total input cost (Hamadeh et al., 1997; Hamadeh et al., 2001; Tami et al., 2005; and Hosri and Nehme, 2006).

Box 6-10 Definitions of key terms used in this section

- *Rangeland:* rangeland is here understood as land (such as meadows and pasture) that is or has been used for livestock grazing. Rangeland is here thus confined to areas that are currently or have in the past been used by animals for grazing, and may therefore not necessarily include all meadows and pasture land.
- *Meadow:* a field of permanent grass used for hay, but also applied to rich, waterside grazing areas.
- Pasture: Land covered with grass or herbage and grazed by or suitable for grazing by livestock.
- *Rangeland degradation:* it is here defined and limited to land that has lost vegetative density and/or diversity, and thus a loss in animal feed productivity that has resulted from livestock overgrazing or other unsuitable land uses (e.g. unsustainable crop cultivation).
- *Livestock:* animals raised, kept, and dealt with for use, profit or pleasure, e.g. on farms.
- *Fodder or animal feed:* Bulk feed for livestock, especially hay, straw, etc.

Source: See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

6.5.1 Current state

Rangeland areas in Lebanon are reportedly losing their vegetative density and diversity. It is cited that overgrazing and mismanagement of rangelands are causing a disappearance of useful species (Hamadeh, 2005 as cited in Darwish and Faour, 2008). The level of degradation has impacts on the economic value of land and on ecological functions that support the present livestock production systems. The reasons behind the land use changes in grasslands and marginal lands are environmental, economic and social. The reduction in available rangeland is due to erosion, agricultural expansion and urbanisation. In Arsal, a semi-arid area in the Anti-Lebanon mountains, livestock farmers are diversifying their farming activity into cultivated rainfed stone fruit production which has led to a 15% reduction in grasslands area between 1962 and 2000 (Darwish and Faour, 2008). In other areas, such as the sub-humid Kfarselouane area, which witnessed a breakdown in traditional grazing practices and reliance on alternative sources of income, grasslands were abandoned to be invaded by forestland and woodland.

Animal stocking rates reportedly exceed the carrying capacity of existing rangelands by 30% where the carrying capacity is estimated at below 2 head/ha (Hamadeh, 2005 as cited in Darwish and Faour, 2008). The extensive livestock production systems rely on rangeland for the majority of grazing in the spring and summer seasons. Different studies estimated the rangelands use as % of diet to range between 40 and 80% (Hamadeh et al., 2001, and Hosri and Nehme, 2006). Livestock graze on grasslands and on crop residues, and herders pay

84 FAO website: <www.fao.org>.

pasture rents or grazing rents to landowners. Rental prices are however independent from the quality of the feeding. Poor rangeland management and overgrazing constitute real risks to the survival of the extensive livestock production systems (Hosri and Nehme, 2006; and Darwish and Faour, 2008).

The number of animals per unit of GDP is lowest in Lebanon among all ENP countries, thus the potential cost of rangeland degradation and potential benefit of improvement are likely to be low. Several studies (Hamadeh et al., 2001, and Hosri and Nehme 2006) have shown that the economic sustainability of small ruminants' production is poor given the low productivity and profitability of this sector. Small ruminants' production supports rural families in the dryland regions which face the risk of internal migration (Srour et al., 2004). A study of livelihood adaptation strategies of livestock farmers in Arsal showed that farmers with migratory flocks which graze rangelands and crop residues have reduced their herds' sizes to adapt to less available grazing sites (Dick et al 2008). In addition, exclusive reliance on small ruminants has become confined to 7% of the farming population in the area. Figures from 1950 to 2002 show that the income generated from livestock production has gradually decreased, while income from other agricultural and off-farm activities has increased.

The grasslands of Lebanon are classified into four main geographic zones (Osman and Cocks, 1992):

1) The hills and foothills above the coastal zone,
2) The ranges facing the Mediterranean Sea,
3) The slopes of the Beqaa Valley, and
4) The Northern Beqaa hills.

The area of grazing land in each zone has not been estimated in previous studies and the original and current yields are not known. The extent and intensity of livestock grazing in the different zones has been studied sporadically. Most of the studies focused on the Beqaa Valley which has half of Lebanon's small ruminant population and contains 40% of rangelands (Hamadeh et al., 1996). An experimental study in the Terbol area of the Beqaa showed that pasture productivity in the winter season of 1984/1985 (Nov-Jan) fluctuated between 250 and 600 kg per ha (Osman and Cocks, 1992).

Semi-sedentary flocks also depend on unharvest crops and crop residues for grazing. Feed supplements are given to small ruminants, especially in the winter season. These are composed mainly of wheat bran and barley grain, in addition to wheat straw, wheat grain, lentil straw and sugar beet pulp (Hamadeh et al., 1996). World price of barley in 2008 was US$ 185 per ton, while local market price averaged US$ 149.6 per ton.

6.5.2 Potential environmental improvements

2020 Baseline

The focus of the BA is on the effect of rangeland degradation on fodder productivity, measured by rangeland fodder yields. The lack of current national and regional information on area and severity of degraded rangeland, as well as the current fodder yield on degraded rangeland limits the setting of a baseline in 2020. The baseline would assume the same

situation as today, i.e. no deterioration in the quality and productivity of rangeland. The price variable would be the projection of real domestic fodder prices or world price of barley in 2020.

2020 Target

The target in 2020 is to improve rangeland fodder productivity by one-half of the difference between the original and current fodder yield in each geographic zone. The improvement could be obtained through controlled grazing and improved management. Osman and Cocks (1992) have argued through field experimentation that shifting of some grazing from spring to winter would help improve the productivity of pastures.

The environmental improvement to be witnessed as a result of achieving the target is the partial restoration of rangeland vegetation cover.

6.5.3 Qualitative assessment of the benefits of reaching the targets

An overview of these benefits is provided in Box 6-11 (e.g., see also CDE, 2009).

Box 6-11 Benefits of improved rangeland management	
Health benefits	Human health benefits are not applicable.
Environmental benefits	Degradation of rangeland can become so severe that it causes loss in biodiversity and also contributes to desertification. Improvement of grazing lands can help restore the ecological functions of the rangelands while preserving the genetic resources of these lands.
Economic benefits	Improved rangeland vegetation cover provides an increase in fodder. The increase in fodder can decrease the need for feed supplements in the grazing, non-winter season for the migratory flocks. Given that feed supplements have a large share in the total input costs of livestock farmers, the increase in rangeland fodder productivity could improve the financial sustainability of livestock farming.
Social benefits	Social benefits of improved rangeland may be less tangible than the economic benefits. However, given the association of livestock farming with rural communities in the drylands, the restoration of rangeland functions can help preserve the way of life of nomads who rely to a large extent on livestock grazing for income.

Source: See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

6.5.4 Quantitative assessment of the benefits of reaching the targets

Where figures that indicate potential environmental improvements are available, the quantitative analysis would have addressed the economic benefits from rangeland fodder productivity. The quantitative benefit of improved fodder productivity is expressed as the increase in animal feed on a hectare of rangeland in one year. Fodder productivity benefits are 50% of the difference between original yield (i.e. the vegetation yields that prevailed prior to degradation) and the current or baseline yield, considering that the baseline yields are assumed the same as current yields, multiplied by the area of the rangeland. The resulting improvement is expressed as tons per year of fodder improvement.

6.5.5 Monetary assessment of the benefits of reaching the targets

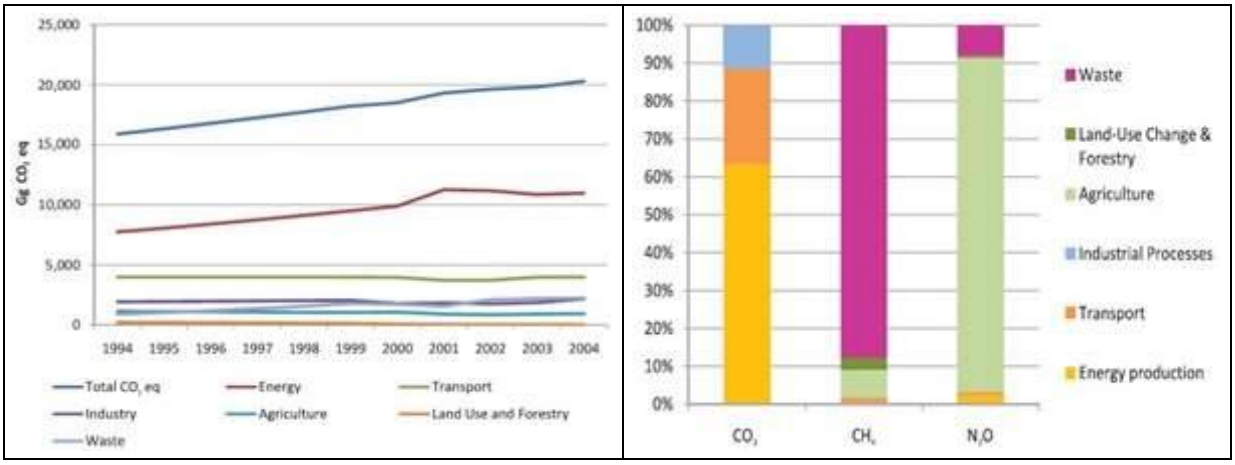
The monetary analysis focuses on the economic benefits of reduced rangeland degradation in terms of livestock fodder productivity improvements. The economic value is the total improvement in tons of fodder per year multiplied by the utilisation rates and multiplied by projected domestic prices of fodder for year 2020, or alternatively projected world prices of barley. The benefits were however not calculated.

7 BENEFITS OF IMPROVING CLIMATE CHANGE RELATED CONDITIONS

7.1 Introduction to climate change related issues

The climate change downscaling model projections suggest that Lebanon will be more affected by climate change affects than the global average by 2040 as temperatures will increase from around 1°C on the coast to 2°C in the mainland, whereas rainfall is projected to decrease by 10-20% leading to a shrinking snow cover during wintertime due to less snow and shortened cold seasons, less runoff (-15%), more evapotranspiration, increased periods of drought (9 days), higher frequency and intensity of extreme events, and higher risks of natural disasters in terms of larger areas prone to floods, forest fires, etc.[85]

Figure 7-1 Absolute and relative greenhouse gas emissions – Lebanon



Source: MOE (2011a).

Yet, climate-driven changes in renewable surface and groundwater are modest (less than 300 million m^3 per year) in comparison to the projected impacts of population and economic growth (973 million m^3 per year) by 2025, which leaves ample room for water resource management improvements. Lower precipitations are expected throughout the country with the largest annual rainfall reductions mainly occurring in coastal zones and within the Beqaa Valley, which could negatively impact the agriculture sector and especially farmers that could notably be forced to migrate from certain areas.[86] In terms of carbon emissions, energy (53.5%), transport (21.4%) and solid waste (9.4%) represent 83.2% of total carbon emissions in 2000 amounting to 18.5 million tons of CO_2 equivalent (Figure 7-1). Also, the growing intensity and frequency of droughts coupled with higher temperatures is significantly increasing the risk of forest fires as the latter are almost wiping out the positive effect of land use and forest carbon sink (82.2% carbon source in terms of fires to carbon sink) in 2000, which has increased since then. By 2040, sea level rise could endanger the direct and indirect use value of the coast and: affect the northern (Akkar) and southern (Sarafand to Nakoura) sandy beaches including Palm Islands and Tyre nature reserves; and exacerbate seawater intrusion along the coast as a yearly 20 mm sea level rise has recently been observed in the Levantine basin. Also, the pattern change of a number of species

85 METAP (2009b); Wilby (2010); World Bank (2011); and MOE (2011a).
86 Wilby (2010).

(mainly insects) has already been studied in Mount Lebanon, and Lebanon could be prone to the emergence or re-emergence of a number of diseases.

This section will cover the following aspects of climate change:

- Uptake of renewable energy sources.
- Analysis of two impacts:
  - Sea level rise
  - Risk of forest fire
- Insights on deforestation in relation to climate change (reviewed under Nature).
- Insights on methane emissions from waste in relation to climate change (reviewed under Solid Waste).

7.2 Benefits from increasing the uptake of renewable energy sources

7.2.1 Current uptake and potential for renewable energy sources[87]

The energy sector in Lebanon is facing critical challenges as it relies on international energy markets for direct imports (97% of the primary energy) as the rising cost of crude oil and oil derivatives imports is being translated by a growing deficit, an increasing household, commercial and industrial marginal spending on energy supply, and higher carbon intensity: energy intensity of US$ 0.8 per kg of CO_2 with 1.7 tons of CO_2 released per inhabitant.[88] The shares of the energy sector profile are estimated as follows in 2008: 29% for transport with a car park of about 1.3 million cars or 3.2 inhabitants per car; 51% for residential and others; and 20% for industry.[89] Incidentally, regular power outage has forced dwellers and industries alike to rely on alternative sources of energy through communal or private generators.

The Government of Lebanon with the help of development partners, academia, the private sector, research centres and NGOs, through its research and outreach outlets are actively involved in monitoring the effects of climate change as well as promoting both energy efficiency and renewable energy.

87 The analysis of the benefits of avoided CO_2 emissions from increasing the share of RES of the partner countries energy mix, focuses on total final energy consumption and builds on IEA data for these 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. The use of common assumptions for the countries has led to the renewable share of the total energy consumption being somewhat lower in the final RES figures than would be the case in practice, though not to the extent of changing the overall CO_2 savings significantly (the savings of meeting the ENPI wide target should arguably be a few percent lower on averages). This slight overestimate is thought to be more than offset by the arguably more conservative assumption that energy consumption per capita over the period 2010 to 2020 remains constant, as in reality future increase in demand can be expected to be more than offset by efficiency gains (hence the share of renewables over may be higher). Note that the Benefits Assessment Manual and the supporting spreadsheet tool available to countries have instead been revised using an adjustable set of conversion rates, to offer countries a tool that allows for using more country specific assumptions. Slightly revised values, taking into account some of these country-specific assumptions, have been included in the two regional ENPI synthesis reports, but not in the single country reports as these were already concluded before this additional finalisation of the method (conducted beyond the end of the project). 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.

88 ALMEE website: <www.almee.org>.

89 MOE (2011b).

7.2.2 Potential environmental improvements

The 2009 Ministerial Statement sets a 12% renewable energy (RE) target for Lebanon and also called for the establishment of the Lebanese Centre for Energy Conservation (LCEC). Additionally, the MOEW Energy Policy Paper approved by the Council of Ministers on 21 June 2010 called for the institutionalisation of the MOEW-based LCEC and the adoption of the Energy Conservation Law that should be submitted soon to the Council of Ministers. Both the 2009 Ministerial Statement and the Energy Policy Paper guide the on-going energy efficiency (EE) and RE initiatives. Moreover, the "National Energy Efficiency and Renewable Energy Action (NEEREA), which was set up under Banque du Liban Circular No. 236/2010 as a national financing mechanism, develop the ESCO (Energy Service Company) business dealing with energy audit applications. Hence, NEEREA is the national financing mechanism to support the financing of environmentally friendly projects (EE, RE, ecotourism, recycling, etc.) although there is no legislative institutional and regulatory (no legal, market, fiscal or moral suasion instruments) framework. The MOEW is playing an increasing role with the support of development partners on electricity generation, industry, residential and tertiary sector although EE in the transport sector remains an afterthought:

- The MOEW 2010 electricity sector reform plan (US$ 4.87 billion over 4 years) calls for an installed and "running" capacity expansion of 3,500 MW between 2015 and 2030 based on 2/3 natural gas (offshore gas reserves are estimated between 707 and 2,264 billion m^3 but are still unexploited) fuel energy mix (currently mainly fuel) and 12% of RE by 2014 in term of (Box 7-1): hydro (310 MW), wind (80 MW), waste to energy (20 MW), solar (0.5 MW) and possibly geothermal. The MOEW is distributing 3 million Compact Fluorescent Lamps equivalent to potentially cutting down on the installation of a 40 MW power plant. Yet, the Electricité du Liban (EDL) under the tutelage of the MOEW is neither effective (1,600 MW operational out of 2,307 MW installed) nor efficient (production cost almost twice as much as tariffs that were set without discounting for inflation in August 1994 when the price of oil was US$ 21/barrel, and requiring a subsidy equivalent to 17% of the energy bill) with industrial losses due to outage estimated at US$ 400 million per year and households are spending 25% more on electricity bills to meet their electricity needs through informal private and household power generators (9% of total production of 12,000 GW/h in 2009 with EDL providing the rest through 85% thermal and 6% hydroelectric power).

- The MOEW-based LCEC aims to reduce GHG emissions in Lebanon by improving demand side energy efficiency through the provision of energy efficiency services to the public and private sectors. The LCEC has helped a number of businesses reduce their electricity bill and hence their carbon footprint that was also translated in terms of EDL cost savings (forgone subsidized generation cost). The average amount of savings is more than € PPP 1.15 million in 2008 prices over the 2006-2009 periods with a CO_2 equivalent emission reduction of just about 3,000 tons per year.

- The Ministry of Finance (MOF) co-signed a Sustainable Energy Strategy (SES) project with UNDP in 2008 with MOEW and MOE representation in the taskforce. Within this project, MOF studies fiscal incentives that can be adopted to encourage energy efficiency, renewable energy and better environmental practices. The MOF has committed to building capacity within the ministry for this purpose with the support of

UNDP. Two of MOF's buildings are undergoing implementation of EE measures as part of the Country Energy Efficiency & Renewable Energy Demonstration Project for the Recovery of Lebanon (CEDRO) project following audits overseen by the LCEC. Also, a number of measures have been adopted by MOF including Article 83 in the 2010 proposed budget law that stipulates full exemption from customs fees for hybrid cars. There have been substantial increases in allocations to energy related expenditures in the 2011 Budget Proposal such as to the National Initiative to Rationalize Energy Consumption and LCEC. Additionally, the MOF provides subsidised loans in four sectors (agriculture, hospitality, IT and industry) including for environmental and energy investment. These private sector loan programmes are managed by Banque du Liban.

- A number of institutions and NGOs are also active in the field such as: the National Council for Scientific Research; the Lebanese Agricultural Research Institute; the Lebanese Association for Energy Saving and for Environment (ALMEE) which covers global environment issues (Kyoto and Montreal protocols) and has extensively worked on developing proposed mechanisms for GHG emission reduction; the Lebanese Cleaner Production Centre (LCPC) which demonstrates cleaner production methods and provides technical assistance to facilitate the adoption of cleaner technologies and pollution prevention techniques; the Lebanese Solar Energy Society; Greenline; etc.

- A number of EE and RE-related activities or guidance reports have also been achieved: greener building code (Capacity Building for the Adoption and Application of Thermal Standards for Buildings); a joint cooperation between BDL, UNDP, the EU and MOEW-LCEC, Lebanese banks and private investors have set up the NEEREA that is providing loans (€ 24 million to be leveraged by € 75 million) that encourage cleaner production and renewable energy (Box 7-1); the Spanish-funded CEDRO has promoted small-scale renewable energy sources (Photovoltaic systems, solar hot water systems, ground sources heat pump technology and currently working on microwind and pico-hydro) and financed the national bioenergy strategy, the national Wind Atlas, and is currently working on releasing a study on geothermal assessment; etc.

Based on the International Energy Agency, the total primary energy supply (TPES) amounts to 5,242 kTOE in 2008 with electricity production, transport, buildings and industry absorbing the largest share. The total final consumption amounts to 3,562 kTOE in 2008 (Table 7-1). The ensuing CO_2 emissions are estimated at 15.5 million tons of CO_2 with 97% generated from oil products.

The 2010 MOEW electricity sector reform plan addresses both supply and demand-side management issues and is articulated along three strategic building blocks:[90]

- Infrastructure: electricity production, transmission and distribution.
- Supply and demand: choice of fuel and outsourcing, RE, EE, and tariffs.
- Legislation: norms and standards, corporatisation of EDL, and legal status.

90 MOE (2011b).

Table 7-1 Total primary energy supply - Lebanon, 2008

Supply and consumption	Coal and peat	Oil products	Hydro	Solar	Combustible renewable and waste	Electricity	Total
	kTOE	kTOE	kTOE	kTOE	kTOE	kTOE	kTOE
TPES	**132**	**4,867**	**32**	**21**	**142**	**48**	**5,242**
Electricity Plants		*-2,395*	*-32*			*914*	*-1,513*
Other Transf.	*0*	*0*	*0*	*0*	*-23*	*0*	*-23*
Losses	*0*	*0*	*0*	*0*	*0*	*-144*	*-144*
TFC	**132**	**2,472**	**0**	**21**	**119**	**818**	**3,562**
Industry	**132**	**328**				**215**	**675**
Transport	**0**	**1,511**					**1,511**
Other	**0**	**563**		**21**	**119**	**603**	**1,306**
Residential	*0*	*563*		*21*		*312*	*896*
Commercial and Public Services	*0*					*137*	*137*
Non-Specified	*0*				*119*	*154*	*273*
Non-Energy Use	**0**	**70**					**70**

Source: IAE website: <www.iae.org>.

With the choice of fuel, the plan favours a 2/3 gas and fuel mix. With regards to RE, the plan is in line with the non-binding Copenhagen climate conference as Lebanon officially pledged to meet 12% of its energy consumption from RE sources by 2020. However, given the current state of EDL (see above), the target seems too ambitious and costly to be achieved as it will be difficult to supply 880 out of 8,000 kTOE yearly by 2020 through RES.[91] However, through NEEREA, a number of activities are being planned that could help achieve some of the EE and RE targets (Box 7-1).

Although the Energy Policy Paper and the Energy Strategy were adopted by the Council of Ministers in June 2010 and September 2011 respectively, their implementations however remain a challenge giving the political uncertainty that prevails in Lebanon since 2001 and the difficulty of moving forward a reform agenda in Lebanon given the past reform experiences that suffered from the lack of governance and strong political interference. The private sector drive is however already compensating for the lack of EDL's energy generation and its growing EE and RE involvement will be developed in parallel to the badly needed public sector reform, and strategic energy sector choices.

Box 7-1 NEEREA planned projects - Lebanon

Some 100 MW of wind turbines farms are planned by 2014 at a total cost of US$ 115 – 190 million. The wind atlas of Lebanon was completed under the supervision of CEDRO. The document will make available much needed data that will boost wind turbine (WT) installation in Lebanon.
The Domestic Solar Water Heater (DSWH) campaign "One DSWH for every house" has already been launched. It is planned that 190,000 m² of DSWHs will be installed by 2014. Annual sales of 50,000 m² are expected by that year with subsequent growth to reach 1 million m² by 2020. All buildings in Lebanon should be retrofitted

91 MOE (2011b).

with DSWH. Currently, installed DSWHs do not exceed 210,000 m². MOEW will subsidise this programme to the tune of US$ 200 per grant for the first 7,500 applications. The units will be financed at 0% interest rate over a 5-year period (Banque du Liban Circular 236, November 2010) and payments shall be made through the electricity bill.

On the photovoltaic (PV) front, some 100-200 MW of PV farms are planned to be installed by 2013, which seems to be over-ambitious. As described earlier, CEDRO already completed 40 KWp of PV for individual institutions and plans to install another 40 KWp in 2011.

Some 100 MW of hydro and micro-hydro projects are contemplated by 2015 at an approximate cost of US$ 500 million, with significant private sector investment.

Decentralised WT and PV installations at the consumer premises. Contemplated installed power varies between 50-100 MW at a total cost of US$ 250 - 500 million through long-term loans to citizens.

Geothermal and waste to energy projects are expected to generate 15-25 MW at a total cost ranging from US$ 30 - 50 million. With respect to waste-to-energy, it may be worthwhile noting that such projects need careful consideration taking into account the environmental implications of burning waste even if at very high temperatures.

Source: MOE (2011b).

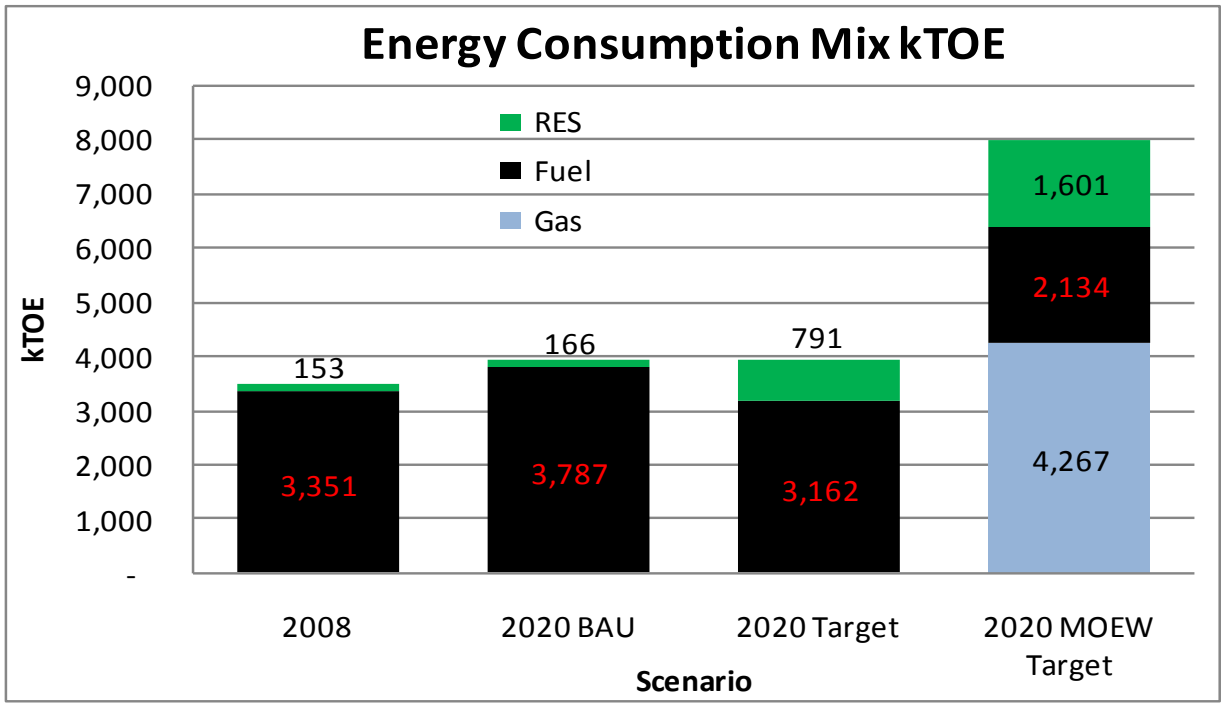
2020 Baseline

The main drivers of energy consumption are climate change, economic growth and demographic growth. The 2020 baseline will factor in demographic and economic growth when the fuel mix shares remain the same as 2008 with a 4.2% RES and a target 2020 where 20% will be generated through RES to determine the global gains. The MOEW's over ambitious 2020 plan is also depicted as a fourth column in Figure 7-2 for comparison purposes only but the carbon gains are calculated under monetary benefits as the MOEW is planning to double the installation capacity to 8,000 kTOE in 2020.

2020 Target

The 2020 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% by 2020 (Figure 7-2). However, the 20% target is arguably far from realistic as the 2020 MOEW plan calls for a 12% RES (1,601 kTOE). That said, the latter assumes much higher energy consumption levels and in practice would be more ambitious in absolute terms than the ENP RES (791 kTOE) 2020 target. The MOEW calls for the doubling of the energy consumption by 2020. The ENP target is therefore more achievable from the perspective of TOE. It is not the ENP's study objectives to comment at the realism/ambition stated government targets, but rather to highlight the benefits of increased RES. The 2020 target is therefore meant to provide an estimate of the benefits of be gained from an ideal illustrative improvement.

Figure 7-2 Energy consumption and RES – Lebanon



Source: IAE website: <www.iae.org>; See the methodological approach in the Benefit Assessment Manual -- Bassi et al. (2011); and Authors.

7.2.3 Qualitative assessment of the benefits of reaching the targets

An overview of key benefits from increased uptake of RES benefits is illustrated in Box 7-2.

Box 7-2 RES qualitative assessment	
Health benefits	Reduced air emissions that can lead to pulmonary diseases. see 'Ambient air quality' in section 3.
Environmental benefits	Reduced contribution to climate change; possibility to associate RES to desalination – hence improving water availability without increasing fossil fuel consumption. It is of course crucial to make sure that possible impacts from RES to the local environment are minimised (e.g., no deforestation caused by biomass, no/limited land use change, etc.).
Economic benefits	Increased energy security (thanks to increased diversification of sources and increased national production), employment opportunities in the RES sector, and possible cost savings in energy production. A number of private sector opportunities could complement the power generation to bridge the demand: ○ Wind power; ○ Lowered treasury transfers to power utilities when public or private renewable energy is favoured ○ Solar power (water heating is being promoted throughout the country); ○ Waste to energy with an ambitious government program to favour this new technology for BML, Tripoli and possibly other cities; ○ Geothermal, which still needs to be assessed in Akkar in NL and Tyre in SL.
Social benefits	Possibility to provide energy to isolated locations (not connected to the electricity grid)

Source: See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

7.2.4 Quantitative assessment of the benefits of reaching the targets

The quantitative assessment determines the increased substitution of fossil fuels with RES, resulting in a decrease in CO_2 emissions. The estimated hypothetical amount of CO_2 that will not be emitted should the target of 20% RES uptake be reached is illustrated in Table 7-2: a reduction of 625 kTOE of fossil fuels by 2020 with a reduction of 2,731 kTOE of CO_2 equivalent. Although the resulting air quality improvements will be primarily local and national in scale, the reductions in climate change impacts are assumed to be spread globally.

Table 7-2 Quantitative benefits of meeting improved RES targets – Lebanon, 2020

Quantitative benefit		**Environmental improvement (reduced fossil fuels)**	**Reduction in the consumption of coal/peat in 2020**	**Reduction in the consumption of oil in 2020**
		kTOE	kTOE	kTOE
Energy	kTOE	625	24	601
CO_2	$ktCO_2$ equivalent	2,731	91	2,640

Source: See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

7.2.5 Monetary assessment of the benefits of reaching the targets

The monetary value of carbon is based on the European Commission[92] as a lower bound and the French study[93] as an upper bound. The total monetary benefits from reduced emissions due to increased uptake of RES has been estimated at between € 107 and 153 million for the year 2020 based on the lower and higher carbon price scenarios. The benefits over the period 2010 to 2020 would start lower (as current RES is far from 20%) 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.

Table 7-3 Monetary benefits of meeting improved RES targets – Lebanon, 2020

Monetary benefit	**Reduced amount of CO_2 emissions if target met**	**CO_2 value 2010**	**CO_2 value 2020**	**Monetary benefit (2010 values)**	**Monetary benefit (2020 values)**	
	$ktCO_2$	€/ton CO_2	€/ton CO_2	€ million	€ million	LP billion
Lower bound	2,731	17.2	39	47.0	106.6	139.3
Upper bound	2,731	32	56	87.4	152.9	200.0
Midpoint	**2,731**	**24.6**	**47.5**	**67.2**	**129.8**	**169.7**
% of 2020 GDP					**0.3**	**0.3**

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

Alternative scenario: an alternative valuation is performed on the 2010 MOEW reform plan that was conducted under the Second Communication where the total $KtCO_2$ equivalent avoided in 2020 (although it is calculated until 2030) that is based on two scenarios energy mix as illustrated in Table 7-4 with the first and second scenario assuming an 11.4% and 17%

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

for RES respectively. The results are illustrated in Table 7-5 with € 560 million in terms of monetary benefits equivalent to 1.2% of 2020 GDP.

Table 7-4 MOEW mitigation scenario 1 and 2 - Lebanon

Energy source	Exogenous capacity (MW)	
	Mitigation scenario 1	**Mitigation scenario 2**
Oil	2004: 2,038 2014: 2,538 2030: 1,230	2004: 2,038 2014: 2,538 2030: 0
Diesel	2004: 0 2014: 300 2030: 0	2004: 0 2014: 300 2030: 0
Natural gas	2004: 0 2014: 1,618 2030: 4,690	2004: 0 2014:1,618 2030:5,850
Hydro	2004: 274 2014: 310 2030: 400	2004: 274 2014: 310 2030: 600
Wind	2004: 0 2014: 80 (+8% as of 2016) 2030: 254	2004: 0 2014: 80 (+10% as of 2016) 2030: 334
Solar	2004: 0.5 2014: 0.5 (+8% between 2021 and 2030) 2030: 81	2004: 0.5 2014: 0.50.5 (+10% between 2021 and 2030) 2030: 130
Waste to Energy	2004: 0 2014: 20 (+8% as of 2016) 2030: 63	2004: 0 2014: 20 (+10% as of 2021) 2030: 130
Imports	2004: 200 2014: 300 2030: 300	2004: 200 2014: 300 2030: 0
Self generation	2004: 1,000 2014: 0 2030: 0	2004: 1,000 2014: 0 2030: 0
2030 Total	**7,019 of which 11.4% from RES**	**7,044 of which 17% from RES**

Source: MOE (2011a).

Table 7-5 Monetary benefits of meeting new energy mix targets – Lebanon, 2020

Monetary benefit	GHG Emissions 2008	GHG Emissions 2020 BAU	GHG Emissions 2020 Target	CO_2 value 2010	CO_2 value 2020	2010 Value		2020 Target	
	$ktCO_2$	$ktCO_2$	$ktCO_2$	€/ton CO_2	€/ton CO_2	€ million	LP billion	€ million	LP billion
Scenario 1 lower	12,000	23,000	14,000	17.2	39	155	202	351	459
Scenario 1 upper	12,000	23,000	14,000	32	56	288	377	504	659
Scenario 2 lower	12,000	23,000	13,000	17.2	39	172	225	390	510
Scenario 2 upper	12,000	23,000	13,000	32	56	320	418	560	732
% of 2020 GDP								**0.1**	**0.1**

Source: See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

7.3 Benefits from adapting to climate change

7.3.1 Key climate change impacts that are expected to affect the country

Lebanon's 2011 Second National Communication to the UNFCCC suggests a number of cross-sectoral adaptation and mitigation measures that will urgently need to be prioritised based on costed multi-criteria risk analysis. The sea level rise and forest fires vulnerability are selected, reviewed and based on the Second National Communication recommendations.

Sea level rise

Climate change affects in terms of sea level rise will contribute to factors already affecting coastal zones in terms of less sedimentation of the Eastern Mediterranean coast since 1963 due to the construction of the Aswan Dam, less coastal sedimentation due to less runoff from rivers over the years and anthropogenic causes (unchecked extraction of shore sand for construction although banned) and natural effects (sea surge). The coastal zone will be increasingly prone to heavy rains during November and December, and storm surges that could occur simultaneously (clogging the drainage network hence increasing the coastal flood intensity) while sea level rise will exacerbate coastal erosion over the next decades with a direct effect on the livelihood of coastal inhabitants, infrastructure and tourism activities. The low lying areas of the Lebanese coast are already receding[94] and potential sea level rise could accelerate the process. Sea levels have been continuously rising at an average rate of approximately 20 mm per year in the Levantine basin. If it were to continue to increase linearly in the future, it can reach up to 25 cm in 2020 years, which will have an impact on the sand beaches in the south, the coastal natural reserves such as the Palm Islands and the Tyre nature reserves, and coastal aquifers with an increase in seawater intrusion. These vulnerable coastal areas will be increasingly prone to flooding and inundation especially in river mouth areas during sea storms (Figure 7-3).

Forest fires

Forests' coverage has been fragmented due to poor land use practices with pressures from the construction business and agriculture. Climate change affects will increase the risk of fragmentation, pest outbreak, insect infestation and forest fires. A significant change in bioclimatic levels due to higher temperature and lower precipitation will also affect forests in Mount Lebanon (Arz el Chouf), Northern Lebanon (Tannourine), Akkar and Hermel with the upper zone coniferous forests (*Cedrus libani; Abies cilicica*) and high mountain formations (*Juniperus excelsa*) being the most at risk. Prolonged drought periods are expected to increase the frequency and periodicity of fire events mainly affecting *Pinus halepensis* and *Juniperus as t*he regeneration rate for these species is expected to decrease (Figure 7.2).

94 Abi Rizk (2005).

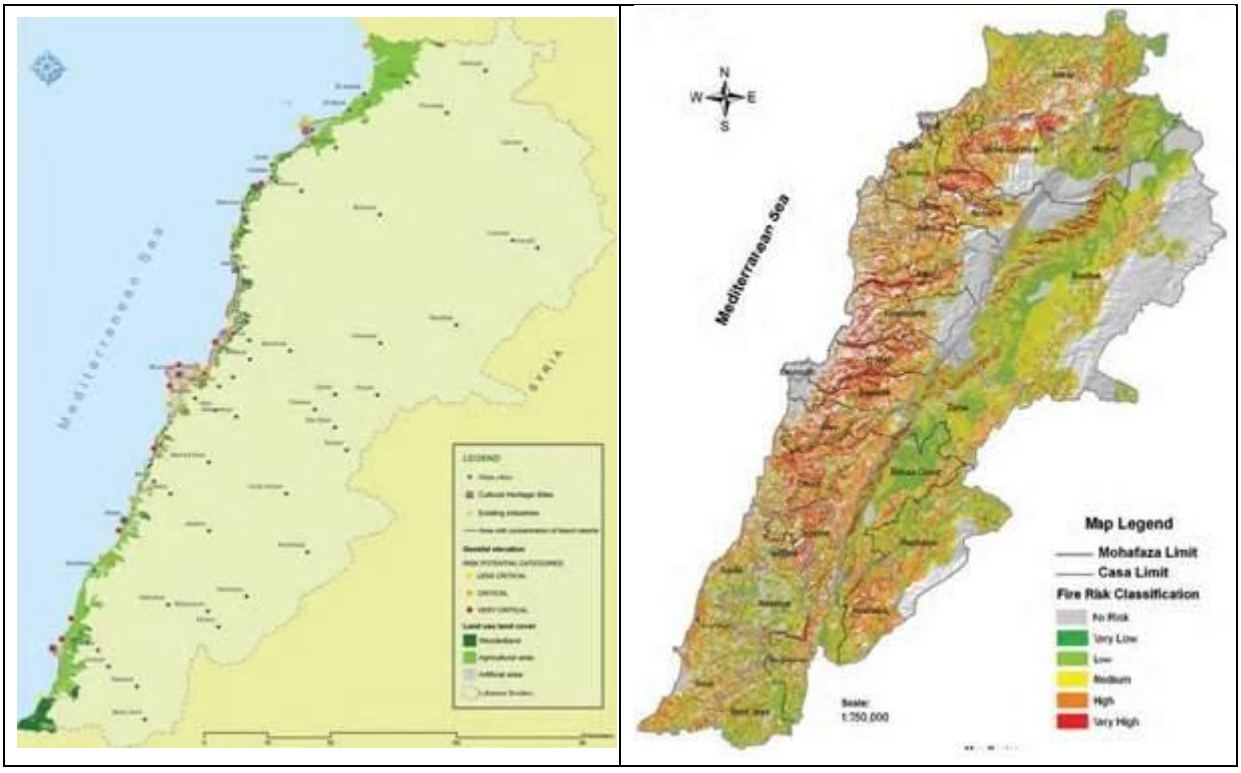
7.3.2 Potential environmental improvements

Selectively, adaptation for coastal zones and forests are discussed.

Coastal zone adaptation

The adaptation strategy for coastal zones should speed up the ratification by the Government of Lebanon of the 2008 Barcelona Convention Protocol on Integrated Coastal Zone Management in conjunction with the implementation of the 2005 NPMPLT that will help organise and control the coast.

Figure 7-3 Coastal zone and forest fire vulnerability – Lebanon



Source: MOE (2011a).

Although defensive sea level-rise measures suggest creating a 100-meter setback when possible as suggested by the ICZM Protocol, however, retreat is not always possible where economic activity and settlement exist. Hence, improving the resilience of infrastructure and private structures (tourism, resort, etc.) along the coast, introducing effective early warning systems for coastal hazards, and creating protective structures to limit potential damage could be envisaged and implemented.[95] Sea level intrusion will also affect the well-irrigated coastal agriculture but will not be addressed in this context.

Introducing protective costs vary according to the retaining structures considered as the least cost solution should be considered first: dune management; construction of epis; soft structures (artificial reef built with sand bags) and finally the hard structures (rocks or road structures along the coast like in Akkar or a creation of an artificial reef). The cost-

95 MOE (2011a).

effectiveness of each option should carefully be assessed and a pilot phase should also be considered.

Sensitivity is higher in low-lying coastal areas such as in Tripoli, Chekka, Amchit, Jbeil, Jounieh, Damour, Jiyeh, Saida and Tyre which are more exposed to tides and have lower natural defence structures (Figure 7-3). All these cities, towns and villages have economic and tourism activities. Applying any of the defensive measures could prevent the coastal erosion and whose benefits could be determined in terms of coastal erosion avoided.

2020 Baseline

Coastal erosion is eating up some of the nicest beaches in Lebanon and coastal zone management is needed to slow down or even reverse the process. In Akkar, the 11-km sandy stretch has lost 2 meters per year on average since 1963.[96] The coastal receding assumption will be more conservative despite the sea level rise of 2 mm per year until 2020.

2020 Target

The coastal erosion avoidance for half the wetland and sandy beaches in Lebanon representing 9.8%[97] of the coast and therefore 4.6% of these stretches is targeted by 2020.

Forest fire adaptation

Adaptation measures are targeted to assist the natural resilience of forests and anticipate future changes. These measures mainly consist of: (i) strengthening of the legal and institutional framework to integrate climate change needs; (ii) the integration of landscape planning in local/regional development plans; (iii) strengthening of awareness and education, and research support; and (iv) the development of forest management plans for the most vulnerable ecosystems (Figure 7-3).[98]

The alarming frequency and intensity of forest fires in Lebanon, lead already to the formulation of a new national strategy to combat forest fires, which was approved by the Council of Ministers in May 2009. The strategy, which was prepared by the Association for Forest Development and Conservation in collaboration with IUCN-Med, the MOE, the MOE, the Ministry of Interior and Municipalities, the Ministry of Defence and co-financed by the Spanish Agency for International Cooperation for Development and the EC, integrates the need for adapting to climate change in order to reduce the risk of harmful fires and build ecological and social resilience faced with the impacts of global change. Moreover, a number of Development Partners have allocated some funds towards forest fire prevention such as the Italian Cooperation (€ 817,000), FAO (€ 1.8 million from 2008-2010) and the EC through various windows (EC-Life: € 319,000 from 2000 to 2005; SMAP-WWF: € 1.1 million from 2000 to 2003), to name a few.

96 Abi Rizk (2005).
97 Faour and Bou Kheir (2006) cited in METAP (2009b).
98 MOE (2011a).

2020 Baseline

Although the net forest cover is increasing in Lebanon due to reforestation efforts (278.3 ha in 2002 and 286.3 ha in 2004 achieved by the MOE),[99] the risks of forest fires are reducing the TEV of forests, especially in the mountains that could be translated into higher risks of floods to reduced carbon sink. In this particular case, a constant forest cover is considered without any increase or reduction of the forest cover over the next 12 years.

2020 Target

The target is based on professional judgment and represents 10% of the forest cover in terms of forest fire area avoided in 2020.

7.3.3 Qualitative assessment of the benefits of reaching the targets

An overview of benefits from coastal zone and forest fire adaptation is illustrated in Box 7-3.

Box 7-3 Coastal zone and forest fire adaptation qualitative assessment	
Health benefits	Adaptation measures will avoid or reduce: o Cardiovascular diseases associated with well water with high sodium content. o Cardiopulmonary diseases associated with inhalation of fumes. o Psychological stress due to the loss of the recreational and relaxation services provided by forests.
Environmental benefits	Adaptation measures will avoid or reduce: o Loss of habitat for animal species diversity; o Disruption of the ecosystem's regulating services such as carbon storage, soil erosion and water conservation, flood prevention or avalanche control, slowing the rate of desertification, and coastal protection. o The risk of disrupting the specific direct and indirect services provided by protected areas and nature reserves.
Economic benefits	Adaptation measures will avoid or reduce: o The loss of opportunities associated with forest and coastal services (tourism, resort, etc.) that generate wealth. Specific examples include the provision of timber, fibres, non-wood forest products such as gums/resins, honey/wax, dying and tanning products, bushmeat and other foods, and medicines. Economic benefits may also 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. Well-managed forests can also attract visitors and hence increase revenues from tourism/recreation. Management of forest for amenity provision or biodiversity conservation may also generate employment opportunities.
Social benefits	Benefits include provision of amenity for recreation, education, tourism, cultural and spiritual heritage.

Source: See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

7.3.4 Quantitative assessment of the benefits of reaching the targets

The coastal erosion avoided will be assessed as follows: 5.6% of the coastal stretch that will be affected by erosion is equivalent to 11,270 meters. A lower bound erosion will be equivalent to 3 meters and an upper bound erosion will be equivalent to 5 meters by 2020. The coastal erosion area avoided ranges between 33,810 and 56,350 m^2.

99 Data provided by the MOE.

The forest fire avoided is 10% ±5% of the forest cover in 2008 that is supposed to be constant until 2020. Hence, forest fire area avoided ranges between 6,850 and 13,700 ha.

7.3.5 Monetary assessment of the benefits of reaching the targets

The monetary benefits associated with the coastal erosion area avoided is equivalent to the land price that is estimated at an average of € PPP 1,000 per m^2 in 2010 along the entire coast with an increase in price per m^2 similar to the GDP growth rate over the period. The opportunity cost associated with any economic activity on the lost land is not considered in the valuation. Hence, the benefits are equivalent to a mid € PPP 135 million in 2010 prices and € PPP 275.3 in 2020 prices equivalent of 0.1% of 2020 GDP (Table 7-6).

The monetary benefits associated with forest fire avoided is equivalent to the forgone TEV[100] of forest area in Lebanon with benefits equivalent to a mid € PPP 1.8 million in 2010 prices and € PPP 2.25 million in 2020 prices equivalent to 0.01% of 2020 GDP (Table 7-6).

Table 7-6 Monetary benefits to adaptation targets – Lebanon, 2020

Monetary benefit	**Area lost avoided**	**Unit cost per m^2 2010**	**Unit cost per m^2 2020**	**2010 Value**		**2020 Target**	
	m^2	€ PPP	€ PPP	€ PPP million	LP billion	€ PPP million	LP billion
CZ erosion lower	33,810	1,000	1,445	33.8	25.9	48.9	112.1
CZ erosion upper	56,350	1,000	1,445	56.4	43.1	81.4	385.4
Forest fire lower	68,500,000	0.0186	0.0269	1.3	1.0	1.8	1.4
Forest fire upper	137,000,000	0.0186	0.0269	2.5	1.9	3.7	2.8
% of 2020 GDP						0.11	0.11

Source: See the methodological approach in the Benefit Assessment Manual --Bassi et al. (2011); and Authors.

100 Merlo and Croitoru (2005).

8 CASE STUDY: BENEFITS OF IMPROVING NON-HEALTH RELATED WATER SERVICES

8.1.1 Overview of current conditions

Due to the Regional Water Establishment (water utilities) service deficiencies in Lebanon, most inhabitants have to augment their water supply or take defensive actions in terms of substituting tap water with bottled water, containers, water wells, trucks or take defensive actions in terms of applying treatment (filtering and possibly boiling) to the water. The mismanagement of water resources and poor service in terms water quality, quantity and regularity was exacerbated since the Civil War, and water reforms and investments introduced after the end of the Civil War did not help improve service quality in general except in a few cases: Saida and Tripoli, where a 4-year contract was awarded to a private operator, ONDEO, to improve the services in the latter city.

Despite these targeted improvements, a mistrust between the dweller and RWEs has been perceived through stated preference surveys where respondents were not willing to pay more than the current water tariff in 2004[101] and up to 1.5 times more than the current tariff in 2009[102] although in both cases, they were actually paying 4 and 3 times more respectively for drinking and domestic water.

The objective of the case study is to determine the consumer surplus that would accrue with the water service improvement in Lebanon in 2020 as section 1 looked mostly at the health benefits associated with these improvements. Hence, the case study complements the BA of water service improvements and the method used here is not the stated preference (WTP) but averted behaviour and defensive measures. The scope of the case study is the entire Lebanese territory and the issue of excess payment on water reveals a number of factors: poor water services, distrust in the service provider, water supply quality, and water quantity and water scarcity, which are not captured in the BA. The latter addresses the burden of water disease mainly from the sanitation improvement and hygiene standpoint, and surface and marine water quality. Hence, a dweller could have proper sanitation, could practice good hygiene and could enjoy pristine watersheds and marine environments and still, the lack of adequate water provision could have a significant social cost. The case study will try to determine this extra cost and assumes a doubling of the water tariffs by 2020, which according to the World Bank and the 2010 Water National Sector Strategy would improve water service quality, quantity and regularity while achieving O&M and partial capital cost recovery.

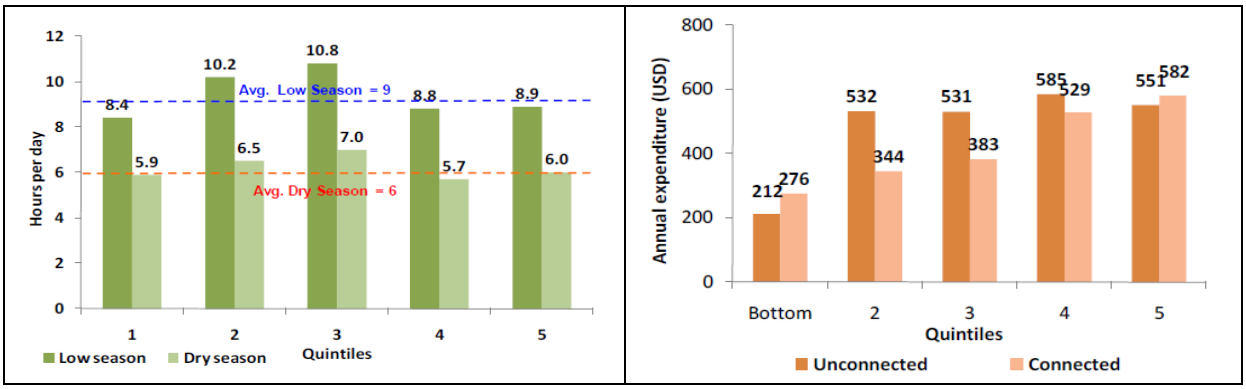
8.1.2 Potential environmental improvements

Currently, most households use 2 to 3 sources of domestic water with costs averaging 3 times the current tariff. The poorest households connected and unconnected to the network have almost the same expenditure on domestic water whereas the second to fourth quintiles household pay substantially more than those connected (Figure 8-1). Improvement of water services in terms of quality, quantity and regularity (Figure 8-1 for seasonal number of hours that water is provided by quintile) will even out the household expenditure

101 Ministère de l'Energie et de l'Eau (2004).
102 World Bank (2009).

discrepancies for the first three quintiles and restore equity among inhabitants. Moreover, the reduction of the demand of alternative water sources will produce less pumping (salinisation of aquifer with their impact on ecosystems, yield, etc.), less truck delivery (usually abstraction is illegal either from groundwater, surface water or tapping into the network), and less reliance on gallon water and bottled water. Hence, it is expected that the household marginal benefits from the water provided through the public network will exceed the marginal cost of a number of water substitutions by 2020.

Figure 8-1 Seasonal water provision and household expenditures by quintile – Lebanon, 2008



Source: World Bank (2009).

Currently, total household expenditure on water amounts to € PPP 529 million although the theoretical household expenditures (based on good quality, quantity and regularity of the public network with 100% coverage and applying the current water tariff) would come to € PPP 167 million. Hence, inhabitants are paying about 3 times the amount that they should have been paying if the water service delivery was adequate. Moreover, unconnected inhabitants are paying more on average for water (€ PPP 136 per capita per year) than connected inhabitants (€ PPP 123 per capita per year).

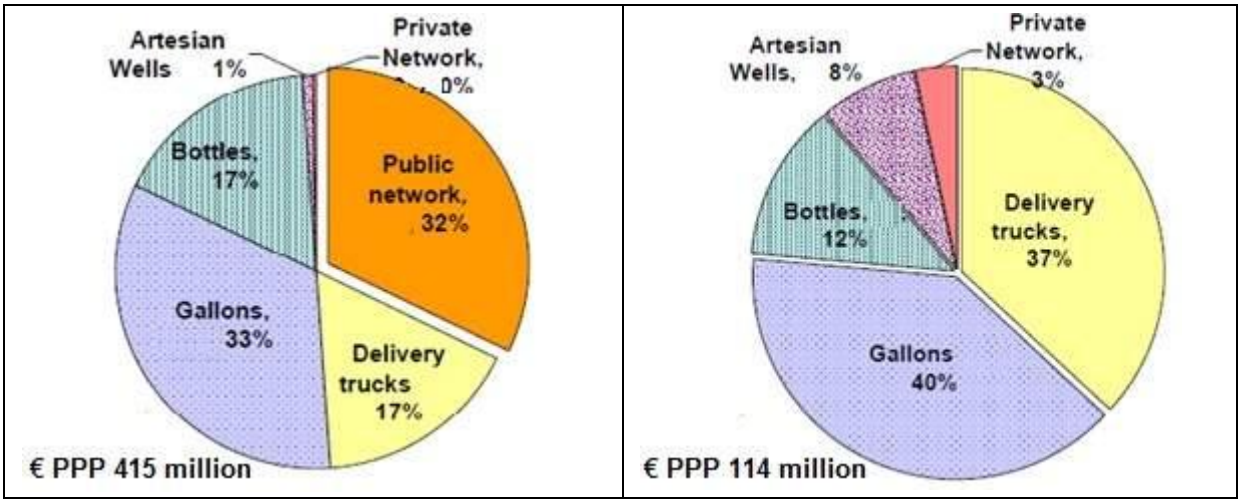
Based on the 2010 National Water Sector Strategy, the MOEW is planning to improve water quality, quantity and regularity by 2015 while doubling the water tariff: the strategy calls for the introduction of a volumetric tariff where meters are installed but this will not be considered in the analysis as price elasticities of demand are not available in Lebanon to determine the consumer behaviour in the future as the tariff will be dynamically linked to consumption.

2020 Baseline

A similar case was performed in Tripoli with a 2005 baseline while ONDEO was managing the water services for four years.[103] The highly subsidised water and sanitation services were quite unreliable as most inhabitants had to supplement their water supply through additional water sources to offset poor quality and low quantity in Northern Lebanon. Inhabitants' drinking and domestic water bills reached on average LP 195,000 per capita per year in 2005, which is more than twice the water tariff of LP 450,000 per capita in Northern Lebanon in 2005 with an actual volumetric water provision representing just a fraction of the volume that should originally have been supplied.

103 METAP (2009b).

Figure 8-2 Connected and unconnected household expenditures by source – Lebanon, 2008



Source: World Bank (2009).

The current case study relies on a survey performed in 2008.[104] Private water supply accounts for 75% of total household water expenditures. The largest alternative water sources for both connected and unconnected households are gallons (35%), followed by delivery trucks (21%) and bottled water (16%). Bottled water (gallon) accounts for the highest share of water expenditures for both connected and un-connected households representing 33% and 40% respectively (Figure 8-2). These results are used to perform the BA derived through better water services. Baseline targets are illustrated in Table 8-2.

2020 Target

For the purpose of the benefits assessment, the following assumptions were made regarding the state of the environment in 2020: household water treatment (filters, etc.) is not factored in; the share of the water multi-sources will remain the same in 2020 with an increase of the population to be connected by 0.9 million (Table 8-1).

Table 8-2 Household multi-sources of water baseline and target – Lebanon, 2020

Multi-sources of water	2020 Baseline		2020 Target			
	Connected	Not connected	Connected		Not initially connected but now connected	
			Low	High	Low	High
Public Network	96%	0%	100%	100%	100%	100%
Private Network	2%	10%	0%	0%	0%	0%
Well	3%	12%	1%	1%	2%	4%
Delivery Truck	13%	25%	0%	0%	0%	0%
Bottles	15%	12%	8%	9%	6%	7%
Gallons	39%	40%	8%	12%	8%	12%

Source: Adapted from the World Bank (2009); METAP (2009b); and Authors.

104 World Bank (2009).

The 2020 share of the water multi-sources are compared to a 2020 target of:

- 100% public connection rates, which includes the private network that are included under public connection and assumed to be supervised by RWEs to provide the same service quality;
- A 70 to 80% reduction in wells (water is used for gardening) and gallon water consumption (currently being bought to substitute for poor water quality);
- A 40 to 50% reduction of bottled water; and
- An abandonment of truck deliveries as they will be unnecessary.

8.1.3 Qualitative assessment of the benefits of reaching the targets

An overview of key benefits derived from improved water services in Lebanon is illustrated in Box 8-1, which reflects the range of goods and services that are provided to society by better water services. Some of these benefits have been covered under other sections of this document.

Box 8-1 Benefits associated with the provision of water service improvement	
Health benefits	– With increased water quality and quantity, the risk of water-borne diseases will be reduced especially for the population that is unconnected to the water public network, namely the poor, schools, etc.; – Health services will be put towards treating non-communicable diseases; – Treatment could still be practiced though to reduce the risk of contamination from common bacteria (such as faecal coliforms) to a minimum.
Environmental benefits	– Physical effects are translating in Lebanon into biological impact, i.e., ecosystem damage and biodiversity loss as less abstraction will be performed through wells and by delivery truckers that usually supply well, surface and network water without any kind of control. – Protected catchment areas will also improve ecosystem services and less abstraction from wells will reduce aquifer salinisation. – Water treatment will be less costly if surface water quality is improved (Surface Water Section)
Economic benefits	– Water service effectiveness, efficiency and equity improvement in Lebanon can: o increase allocative efficiencies at the macro level (Pareto optimality); o Increase consumer surplus as inhabitants will have to pay less water bills; o reduce RWE operating costs (unaccounted for water) and remove the subsidy that could be put towards better use; o increase private participation in the water delivery through contracting out services ; o affect some businesses such as truckers and gallon water producers, which actually treat and resell tap water; o reduce the need for pumping that is translated into less electric and gas consumption, salt intrusion and pollution; o enhance the potential for tourism with clean and regular water services.
Social benefits	– Piped water connection with reliable and continuous good quality water supply provides increased convenience from having potable water available at premises. – Piped water connection with reliable and continuous good quality water supply will free up some time, especially for women, girls and the poor – Access to good quality piped water also improves the public's perceptions of utilities and the state providing good quality services.

Source: Bassi et al. (2011); and Authors.

8.1.4 Quantitative assessment of the benefits of reaching the targets

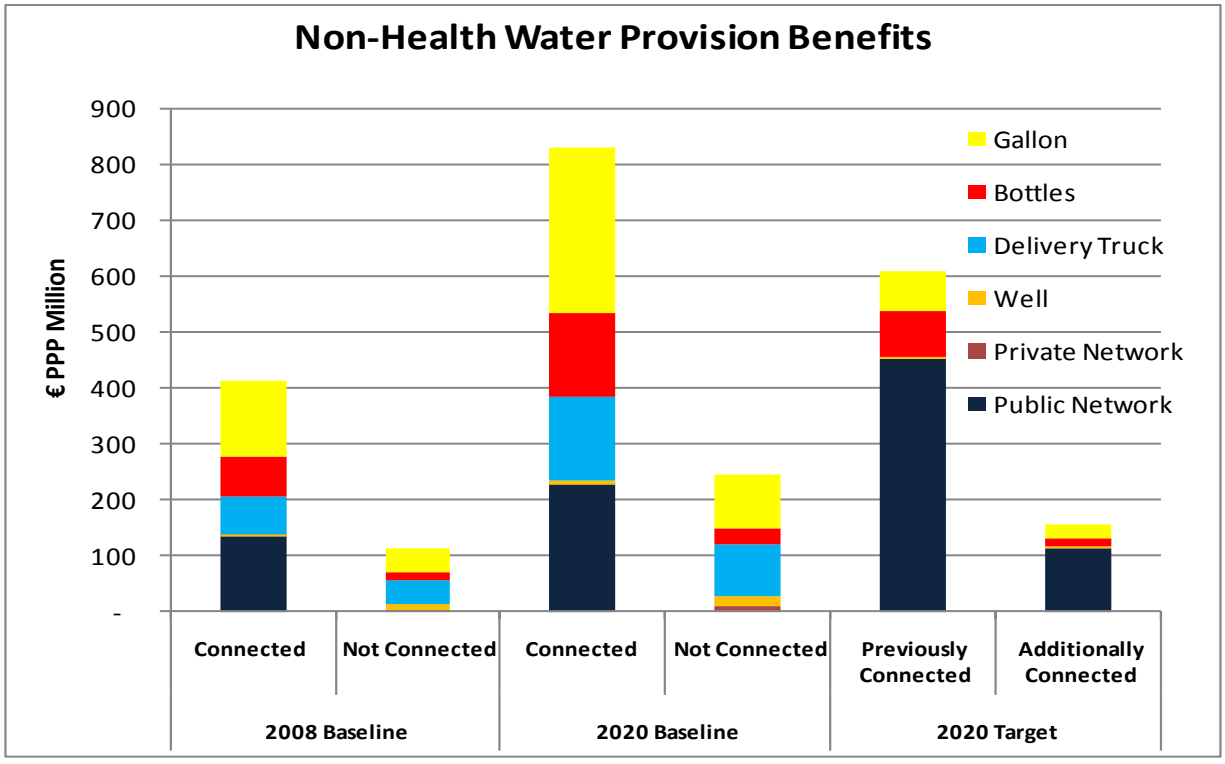
The quantitative assessment provides the aggregated cost incurred by households in the 2008 baseline, 2020 baseline with the business as usual and the 2020 target. Water tariffs are doubled and prices of alternative sources increase by 2.03% per year (GDP per capita projected rate) between 2008 and 2020. The results are illustrated in Table 8-3 and Figure 8-3.

Table 8-3 Quantitative benefits of meeting water provision targets – Lebanon, 2020

Quantitative benefit	2008 Baseline		2020 Baseline		2020 Target	
	Connected	Not connected	Connected	Not connected	Previously Connected	Additionally Connected
	€ PPP million	€ PPP million	€ PPP million	€ PPP million	€ PPP million	€ PPP million
Public Network	134	0	26	0	452	113
Private Network	1	4	1	8	0	0
Well	4	9	8	19	2	2
Delivery Truck	69	42	150	91	0	0
Bottles	69	14	150	30	82	17
Gallon	138	45	296	97	74	24
Total	**415**	**114**	**832**	**247**	**611**	**156**

Source: Authors.

Figure 8-3 Quantitative benefits of meeting water provision targets – Lebanon, 2020



Source: Authors.

8.1.5 Monetary assessment of the benefits of reaching the targets

The monetary assessment is based on the value of benefits in the target year 2020 or in other words the annual benefits in 2020 itself as compared to the 2008 baseline in 2020 prices. The annual benefits to society in 2020 of achieving the targets are estimated at € PPP 282-341 million or LP 365-441 billion, equivalent to about 0.7% of 2020 GDP. The consumer surplus is therefore equivalent to € PPP 311 million or LP 403 billion in 2020 (Table 8-4).

Table 8-4 Monetary benefits of meeting water provision targets – Lebanon, 2020

Monetary benefit	**2020 Target**					
	€ PPP million			LP billion		
	Low	High	Mid	Low	High	Mid
Public Network	-339.2	-339.2	-339.2	-439.0	-439.0	-439.0
Private Network	9.7	9.7	9.7	12.5	12.5	12.5
Well	22.7	24.4	23.6	29.4	31.6	30.5
Delivery Truck	241.1	241.1	241.1	311.9	311.9	311.9
Bottles	72.0	90.1	81.0	93.2	116.5	104.9
Gallon	275.4	314.8	295.1	356.4	407.3	381.8
Total	**281.7**	**340.7**	**311.2**	**364.5**	**440.9**	**402.7**
% of 2020 GDP			**0.7**			**0.7**

Source: Authors.

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Annex I Surface Water Benefit Transfer

The TEV of water is a combination of use and non-use type of values (Table A.1). Use values include direct use and indirect use values. Non-use values include existence values, option and bequest values. An example based on hypothetical improvements in river water quality has been chosen to explain each category:

*Use Value*s arise from the actual and/or planned use of the service by an individual, and be direct or indirect:

- Direct, such as when an individual makes actual use of the environmental asset improved, for example, fishing where it was not possible to catch a fish before the improvements in water quality took place;
- Indirect use values are the benefits derived from ecosystem functions gained, for example, where recreational activities are created or enhanced due to water quality improvements, individuals can benefit in the form of increased recreational opportunities without having to make a direct use of the resource (e.g., walking alongside the river bank).

Non-use values are often divided into:

- Existence values, which arise from knowledge that the service exists and will continue to exist, independently of any actual or prospective use by the individual. This type of use refers to the economic value people place on improvements to the quality of a river due to some moral and/or altruistic reasons, or for the mere pleasure of knowing that the river's water has been enhanced;
- Option values refer to the value place on resource's future use. Because individuals are not sure whether they will use the resource in the future, they are willing to pay to maintain the ability to use it;
- Bequest value is the value an individual places on the ability to preserve a resource so that it can be used by future generations.

Table A.1 Types of benefits covered with the proposed method

Benefit	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

Source: Adapted from Baker et al. (2007).

The achievement of GES for surface waters in Lebanon is important because of the current trends in water pollution and availability. These are in most cases beyond the assimilative capacity of the aquatic ecosystems, which make freshwater quality a principal limitation for sustainable development.

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 in Lebanon (below standards);
- Average income levels per household in Lebanon (World Bank);
- Education levels in Lebanon (World Bank);
- Population number, Household Gender composition and Household occupancy in Lebanon (World Bank);
- Other socio-economic data: GDP in local currency, € and PPP conversion factors and projections in Lebanon (World Bank).

These parameters are used in the WTP formulae to directly calculate the annual Willingness to Pay (WTP) for set improvements in freshwater quality per household per year.

Considering the benefits derived from water quality improvements is essential for making sound decisions regarding the country's aquatic ecosystems and habitats. Decisions could for example relate to efficient and equitable infrastructure investment in the water sector, to the efficient degree of waste water treatment and to the design of policy measures, including economic instruments such water pricing or taxes on water depletion and pollution.

Society's preferences for environmental improvements do not have a market value and have to be estimated in monetary terms by using valuation techniques. 'Non-market valuation' techniques must be applied to establish this portion of the TEV of water use. Valuation techniques are based either on revealed preference (based on observed market values that can be used as substitutes for the improved environmental resource) or on stated preferences (based on surveys of willingness to pay, especially for household water use and recreational services).

Determining the value of an individual's or community's use of water is very difficult, because water values are highly site-specific, dependent on type of uses, as well as season, water quality, availability and reliability. As for types of uses, people make different uses of water resources, which translate into different values. For example, the value of water for cooling purposes in hydropower is different to that of water used for irrigation in agriculture or for fishing in a lake.

Due to the lack of regional valuation studies on the topic, and the **impracticability, due to time and budget constraints,** to conduct an original valuation study, the Benefits Function Transfer (BFT) approach has been applied to estimate the TEV of cleaner water. 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.

For this report, the benefit functions from Baker et al. (2007) have been transferred to Lebanon. This study has recently estimated the economic value placed by English and Welsh households for water quality improvements at local and national level as a result of implementing the Water Framework Directive (WFD) in the UK. This study is one of few studies that employed a standard WFD ecological-based water quality metrics for description of baseline levels and improvements. As an additional feature, Baker et al. (2007) offers detailed results for two different WTP elicitation methods in the same survey instrument, i.e., Contingent Valuation (CV) using both payment card (PCCV) and dichotomous choice (DCCV) as payment mechanisms. The advantage behind the use of two different elicitation methods for the transfer exercise (the PCCV and the DCCV results) is the need to offer ranges of WTP estimates that are representative for policy purposes and illustrate the uncertainty surrounding the results (i.e., sensitivity analysis).

The benefits from water quality improvements covered in this section by the application of the BFT method are related with the quantifiable portion of the TEV 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 A.1. Important to note that it is not possible to disaggregate values for the different types of uses outlined and that other types of water uses are valued and assessed in other sections of this report.