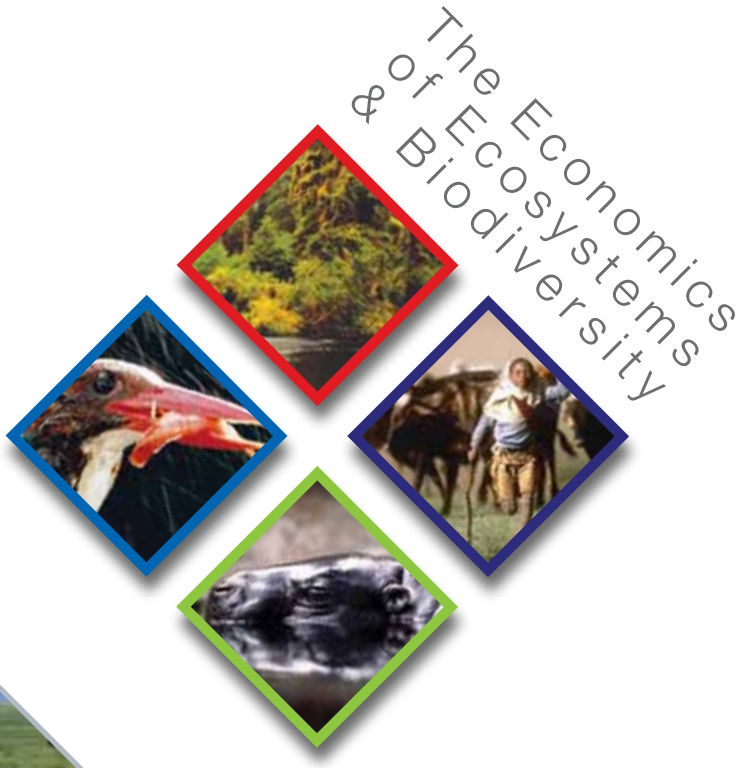
THE ECONOMICS OF ECOSYSTEMS AND BIODIVERSITY FOR WATER AND WETLANDS

A contribution to Rio +20



A Briefing Note

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The Institute for European Environmental Policy (IEEP) is an independent not-for-profit institute. Based in London and Brussels, the Institute's major focus is the development, implementation and evaluation of policies of environmental significance, with a focus both on Europe and the global dimension. IEEP also produces the award winning 'Manual of European Environmental Policy'. Website: http://www.ieep.eu.

The Convention on Wetlands of International Importance, called the Ramsar Convention, is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources.

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1. INTRODUCTION

The "nexus" among water, food and energy has been recognised as one of the most fundamental relationships and challenges for society. Biodiversity and particularly wetland ecosystems are increasingly understood to be at the core of this nexus. Indeed water and wetlands are the foundation for the social, economic and environmental wellbeing of humanity across the globe. The recognition of the value of water and wetlands and integration into decision-making to ensure their wise use are, therefore, essential to meet our future social, economic and environmental needs.

Wetlands[1] provide ecological infrastructure that typically deliver a wider range of services and benefits than corresponding man-made infrastructure. Wetlands are an important, poorly understood, complement to built infrastructure in watershed planning efforts. Ensuring the maintenance and enhancement of the benefits of water and wetlands is, therefore, a key element in a transition to a green economy.

The Economics of Ecosystems and Biodiversity (TEEB) initiative has demonstrated the usefulness of presenting economic arguments on the value of nature, and targeting the messages to different audiences to help improve decision making in public and private sectors. The TEEB for Water and Wetlands work builds on this to generate better understanding of the changing ecosystem service values of water and wetlands to encourage improved decision making and business commitment for their conservation, wise use and investment in their restoration.

This work has been initiated by the Ramsar Convention secretariat, supported by the Norwegian, Swiss and Finnish Governments and the International Union for Conservation of Nature (IUCN). A team comprising the secretariats of The Ramsar Convention on Wetlands and the Convention on Biological Diversity (CBD) secretariats, the Institute for European Environmental Policy (IEEP), International Union for Conservation of Nature (IUCN), the Helmholtz-Zentrum für Umweltforschung (UFZ) and Wetlands International is taking forward this work. The initial aim is to present a TEEB Water and Wetlands synthesis report at the CBD COP11 in October.

This TEEB for Water and Wetlands Brief introduces the new initiative, presents initial ideas on the benefits and questions to be explored over the coming months. Obtaining new and complementary insights from the practical experience of stakeholders (ecosystem managers, communities, municipalities, decision makers from the public and private sector at local, national and international scale etc.) from around the world will be an important element in the development of this work Readers are invited to respond to the questions listed below and to submit further information and case studies (see contact information at the end of the paper).

[1] For the purpose of the Ramsar Convention wetlands are areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres. Article 1, Ramsar Convention (1971)

2. WATER AND WETLANDS: WHAT BENEFITS DO WE DERIVE AND WHAT DO WE RISK LOSING?

Water and wetland related ecosystem services

Biodiversity and ecosystems provide a range of services which benefit people, society and economy at large; these are known as ecosystem services (MA 2005). The intrinsic value of biodiversity and ecosystems is of significance for many cultural services while the direct and indirect use values are fundamental for sustaining people's livelihoods and for many parts of the economy from local to global. Many of these ecosystem services are related to water, including water provision, water purification and waste water treatment, groundwater replenishment and water regulation, including the regulation of extreme events such as floods and droughts.

Water related ecosystem services are crucial for society and underpin most sectors of the economy. Since water availability, and its quality, affect the functioning of all terrestrial, and to a large extent, coastal ecosystems, these services underpin all benefits delivered on land, and many by coastal areas, including the provision of food, drinking water and energy production, carbon storage, tourism and recreation, fisheries nurseries and disaster risk reduction. Public and private sectors of the economy and society as a whole directly benefit from these ecosystem services, including individuals, municipalities, communities and cities, the agriculture, forestry, energy and health sectors, and many others. Some sectors also benefit indirectly, for instance the insurance sector, and all sectors indirectly via the supply chain. At the national and regional scales, the sustainable management of water and related ecosystem services can contribute to national security, health and economic prosperity. **Hence the roles and values of nature in providing these key ecosystem services need to be fully appreciated and integrated into decision making at local, national and international scales.** Incomplete understanding of these ecosystem services can result in undesirable trade-offs between ecosystem services whose values are well reflected in markets (e.g. provisioning services) and those which are not (e.g. regulating and cultural services).

Water security is a major concern in many parts of the world, including both availability and quality of water. Understanding the value of water and wetlands helps provide a firm foundation for protection and enhancement of water resources and, thereby, contributes to delivering secure water resources and improving water allocation and management decisions.

Biodiversity is critical to sustain the water cycle. Biodiversity plays a fundamental role in local and global water cycles (Ramsar, 1971), and a loss of biodiversity can compromise these water cycles, leading to major impacts on people, society and the economy. In turn, water cycles are of paramount importance to biodiversity and to the functioning of essentially all terrestrial and coastal ecosystems.

Without wetlands the water cycle would be significantly altered, and usually detrimentally. Wetlands help regulate the water cycle, including providing a natural water source for direct human uses and as wastewater treatment systems for many towns and cities. Wetlands are some of the most important biodiversity rich areas and provide habitat for many animals. They act as carbon sinks, provide protection from floods and storms and regulate sediment transport and thereby contribute to land formation and coastal zone stability. Other key ecosystem services from wetlands include: groundwater replenishment, nutrient retention and export, wetland products, cultural values, recreation & tourism, climate regulation locally and globally (see Ramsar 2010, MA 2005b, TEEB 2010, TEEB 2011, TEEB 2012).

Meeting sustainable water management objectives cost effectively via ecosystem services from Wetlands

Wetlands provide green infrastructure that delivers a wider range of services and benefits than corresponding man-made infrastructure. Nature based solutions may constitute a lower cost solution than alternative built capital solutions. Human drivers of ecosystem change, such as agricultural land use and pollution, pose a threat to water security for 80% of the world's population and to global freshwater biodiversity (Vörösmarty et al. 2010). In developed countries, costly technical solutions for water treatment are used to reduce some of these negative effects but do little about the source of the problem. Developing countries can often not afford such technical

approaches to water treatment. As a result, the world is off-track in meeting the Millennium Development Goal for basic sanitation. Strategies for integrated water resource management, which balance the needs of humans and nature, can help to enhance water security through maintaining biodiversity and ecosystem services and thereby provide cost-effective options that can also be applied at larger scales (Vörösmarty et al. 2010).

- Ecosystem based water filtration and provision of water, including aquifer recharge, has proven valuable in saving money and safeguarding stable water supply. Examples include the Catskills Delaware watershed in New York (see Case 1 in Annex), the city of Dunedin in New Zealand (see Case 2), the city of Fukuoka in Japan (see Case 3); or a payment for ecosystem services (PES) scheme between indigenous families and the town of San Fernando in Philippines (see Case 4).

- Wetlands also provide valuable waste water treatment services. Wetlands buffer much of Western Cape province's industrial and domestic waste in South Africa (see Case 5); similarly, Nakivubo swamp near Kampala in Uganda cleans water polluted by industrial, urban and untreated sewage waste (see Case 6).

- Finally, wetland ecosystems also provide in many cases an effective natural flood control. The benefits of these services have been demonstrated in the case of the Schelde Estuary (see Case 7); Muthurajawella Marsh near Colombo in Sri Lanka (see Case 8); or Sloping Land Conversion Programme in China (see Case 9).

In addition to direct water services, wetlands can also help offer cost effective solutions to other objectives, such as climate change mitigation. For example, the restoration of peatland in Germany led to significant and cost effective emissions savings, at 8 to 12 EUR/tCO2 equiv. (see Case 10).

Ecosystem services from Wetlands – multiple benefits

Although the value of wetlands for water supply can be considerable, an additional advantage of using them is that they invariably also deliver multiple co-benefits with significant social and economic value and can, in many cases, help to achieve multiple environmental, economic and social objectives as shown in the examples below:

- A comprehensive valuation study of the Mississippi River Delta ecosystem has shown that they provide at least $12-47 billion in multiple benefits to people every year, including natural hazards protection, water supply or recreation (see Case 11).

- A restoration of degraded Manalana Wetland in South Africa helped to secure livelihoods, reduce erosion and improved the state of the wetland and associated provision of ecosystem services (see Case 12).

- The restoration of degraded mangroves in Thailand has been estimated to provide significant benefits from forest products, support of the fisheries or storm protection (see Case 13).

Coastal ecosystems are highly productive; they yield 90 per cent of global fisheries and produce about 25 per cent of global biological productivity (Valiela et al. 2001; UN 2002).

Impacts of wetlands degradation on human well-being and biodiversity

The loss of wetlands can lead to significant losses of human wellbeing and biodiversity, as well as associated loss of ecosystem services with economic impacts on business, communities and countries. Loss of the ecosystem services from water and wetlands can also disproportionately affect the poor. Examples include:

- The degradation of the Aral Sea and surrounding ecosystems, driven by water diversion for, inter alia, cotton cultivation, led to a loss of jobs and economic activities, degradation of environment and detrimental effects on human health (see Case 14).

- Mangroves conversion led to a loss of natural hazards protection services resulting in an increased damage and losses of human lives in Vietnam (see Case 15).

- The reduction in natural floodwaters, due to the large irrigation rice scheme build in 1979, led to significant impacts on biodiversity, ecosystems and human populations around Waza floodplain in Cameroon (see Case 16).

Q: What are the key benefits of water and wetlands? And which are easier or more difficult to demonstrate?

Despite their benefits, the loss of wetlands continues

Status and trends of wetlands: The global extent of wetlands is estimated to be in excess of 1.2 million square kilometres, but this is an underestimate (MA, 2005b). Since 1900, the world has lost around 50 per cent of its wetlands (UNWWAP, 2003). Coastal wetland loss in some places is running at 20 per cent a year (Agardy et al, 2005). Taking mangroves as an example, 20 per cent (3.6 million hectares) of total coverage has been lost since 1980 (FAO, 2007); however this figure rises to 80 per cent in some countries due to conversion for aquaculture, over-exploitation and storm damage (MA, 2005a).

Wetlands continue to face severe pressures, despite many benefits they provide to people and many conservation/restoration successes from recent efforts at local to national to global scales. These pressures arise from major economic drivers and hence there is a need to mainstream ecosystem services into economic decisions. For example, the Millennium Ecosystem Assessment concludes that many water resource developments that have been undertaken to increase access to water have not given adequate consideration to harmful trade-offs with other services provided by wetlands (MA, 2005b). An increased appreciation of the values to society of water related ecosystem services from nature and the wider range of ecosystem services from wetlands in particular, will be essential to catalyse an appropriate policy and business response.

Q: What do you see as the main threats to water and wetlands (including coastal areas)? Are there particular ecosystems which are at greatest risks?

3. MEASURING TO MANAGE BETTER

A diverse range of tools help identify, demonstrate and take account of the benefits of water and wetlands (TEEB 2010, TEEB 2011, De Groot et al 2006), including:

Bio-physical assessments

- Measurement and indicators of the state and trends of biodiversity as well as the flow of ecosystem services are a critical part of the evidence base - e.g. water, biodiversity or ecosystem service indicators, such as carbon sequestration, water retention;

- Mapping the interrelationships between ecosystems, population centres and man-made infrastructure provides essential insights on their interdependencies.

Assessing the value of nature can help demonstrate the importance of nature and be an essential new evidence base for decisions at different levels. This can make use of a mix of qualitative, quantitative, spatial and monetary approaches.

Natural capital and environmental-economic accounts are systematic ways of collating the biophysical evidence base and associated values at regional or national levels to give policy makers a tool to complement national economic accounts. The UN SEEA initiative[2] and World Bank-led WAVES initiative[3] are two prominent initiatives underway.

The CBD Strategic Plan for Biodiversity 2011-2020 includes commitments to raise awareness of the value of biodiversity and to integrate them into plans, strategies and accounts (Aichi Biodiversity Targets 1 and 2). Parties to the CBD are currently revising their National Biodiversity Strategies and Actions Plans to take on board physical assessments of nature and flow of ecosystem services as well as growing number of initiatives to value nature – by non-monetary and monetary means (see **www.teebweb.org** for countries embarking on national assessments). The Ramsar Convention (including its Strategic Plan 2009-2015) is committed to the wise use principles for water and wetlands and actions by Parties to deliver wise use provide important initiatives to protect key water and wetland services.

Q: Are you aware of any initiatives to improve the measurement of the contributions of wetland ecosystems to society and the economy ?

Q: Are these initiatives being linked to NBSAP revisions efforts?

[2] System of Environmental-Economic Accounts (SEEA) see http://unstats.un.org/unsd/envaccounting/seea.asp

[3] Wealth Accounting and the Valuation of Ecosystem Services (WAVES) see http://www.wavespartnership.org/waves/

4. INTEGRATING THE VALUES OF WATER AND WETLANDS INTO DECISION MAKING

Policy synergies: Working with nature can be a cost effective way of meeting a range of policy, business and private objectives. This includes water security (see above) and food and energy security (ensuring water security for agriculture and energy production), poverty alleviation and meeting sustainable development goals collectively. Water and wetlands are at risk from climate change and sustainable management of these ecosystems can increase the resilience of the ecosystems and hence reduce these risks from climate change. Furthermore, the risks of climate change to social cohesion and economic stability have to be addressed and sustainable use of water and wetlands protecting the services they provide is a critical response to enable society to adapt to climate change.

Integrated decision making: The following tools have proven valuable across to take the values of water and wetlands into account and realise synergies in policy, business and management decisions:

- Spatial planning and regulation - e.g. designating water forests for specific city benefits (e.g. water supply), non-conversion zones to safeguard mangroves of important public goods benefits, or protected areas. Effective regulation and careful spatial planning helps control some critical pressures on wetlands, which in turn help avoid flood damage e.g. river restoration in the Napa Valley, USA, to avoid flood damage to built infrastructure (TEEB 2012b).

- Investment to conserve and manage wetland ecosystem services - e.g. restoration of wetlands for mitigating carbon emissions and restoring local water cycle such as in Mecklenburg Vorpommern, Germany (TEEB 2011, Case 10).

- Payments for ecosystem services - e.g. for a range of water services in South Africa's Working for Water programme, or for multiple objectives of water supply, halting deforestation and GHG emissions reduction and addressing poverty in Mexico's PSA-H, and Ecuador's Socio Bosque programme which focuses on poverty and deforestation and mitigate GHG emissions (ten Brink et al 2011).

- Prices, subsidies and subsidy reform - e.g. to encourage efficient use of resources and innovation – e.g. the EU's Common Agricultural Policy reform, requiring that certain minimum conditions for protection of biodiversity are met for farmers to be eligible for subsidies (Lehmann et al 2011).

The Strategic Plan for Biodiversity (2011-2020) includes commitments in these areas: for example, Target 3 focuses on reforming incentives harmful to and crafting policies supportive of biodiversity, Target 4 on sustainable production and consumption and Target 14 on restoring and safeguarding ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and human well-being.

Q: What instruments have worked, where, how have they been launched and made to work, and what benefits have they brought?

5. WORKING RECOMMENDATIONS: TRANSFORMING OUR APPROACH TO WATER AND WETLANDS

There is a need to put water at the heart of the transition to a green economy and recognise the critical role of wetlands and water related ecosystems in the water cycle. Key elements to transform our approach include:

- Appreciating and taking account of the values of nature;
- Commitment to fully integrate management of wetlands and secure their wise use (integrated water resource management);
- Prioritisation for avoiding loss/conversion - by due assessment, spatial planning, regulation, enforcement;
- Restoration - for water, food and energy security, biodiversity conservation, climate benefits (mitigation and adaptation), mitigation of extreme events, and benefits for people and livelihoods;
- Ensuring equitable benefit sharing and social and economic efficiency is important as there will be winners and losers in the transition to a green economy.

There will be a need for action at all levels and across stakeholders if the opportunities of working with nature are to be realised and the risks of losses appreciated and acted upon.

Q: What can different stakeholders do to work with nature and people to realise the benefits of water and wetlands?

Next steps: The TEEB for Water and Wetlands initiative is being launched in Rio de Janeiro on the 15th June (see http://www.uncsd2012.org/rio20/meetings_sidevents.html). It is to be discussed at the Ramsar COP11 in Bucharest, Romania in July, at the IUCN World Conservation Forum in Jeju, Korea in September. The synthesis report will be presented at the CBD COP11 in Hyderabad, India in October. A key element of the TEEB for Water and Wetlands initiative is to reflect on the perspectives, practice and experiences from across countries and stakeholders – to understand which are the successes, needs and potential ways forward to help ensure that nature's role in the water cycle and the benefits from ecosystems are integrated into thinking and practice.

Call for Case Studies!

Please do communicate case practices and insights as this will help reflect interesting practices from around the globe in this work.

Comments on this briefing, answers to the questions and cases examples please send to Patrick ten Brink (Ptenbrink@ieep.eu) or Dr Daniela Russi (DRussi@ieep.eu)

For further information on the initiative write to Dr Andrew Farmer (AFarmer@ieep.eu).

Please add "Water and Wetlands" in the subject line in any communications

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ANNEX - CASE STUDIES

Please do communicate case practices and insights from your countries as this will help reflect interesting practices from around the globe in this work.

Box: Provisional Case Evidence on the values of nature - Value for money from natural capital

Water services

Clean water provision. Forests, grassland and wetland ecosystems can in many cases filter and clean water more cost-effectively than water treatment plants and often their conservation can secure stable water supply:

- **Case 1:** Catskill Mountains, US: US$2 billion natural capital solution (restoration and maintenance of watershed) versus a US$7 billion technological solution (pre-treatment plant). Water rates payers bills would have risen considerably had a nature based solution not been adopted (TEEB 2011).
- **Case 2:** New Zealand: The Central Otago conservation area (Te Papanui Catchment) saved the city of Dunedin NZ$93 million (approximately US$65 million) in water supply costs (BPL, 2006).
- **Case 3:** Degrading forests are affecting the supply of water to the city of Fukuoka, Japan. Collaborative projects with headwater areas and cooperation among local governments, both upstream and downstream, have helped recharge the water capacities of forests. Forest management plans have been initiated to effectively maintain forests even on private lands. (TEEBcase by Hiroshi Nishimiya, 2010).
- **Case 4:** A Payment for Ecosystems Services scheme between the indigenous families, the town of San Fernando and other relevant entities, including governmental bodies, was set up to secure watershed services of an upstream forest. The PES project has provided adequate incentives to attract the indigenous people to participate in patrolling and reforestation efforts. (TEEBcase by Tongson E. and Balasinorwala T., 2010).
- **Case 5:** South Africa: "Wetlands buffer much of Western Cape province's industrial and domestic waste. Waste passes through the wetlands before being discharged into water bodies. A replacement cost approach was used to estimate the value of the wetlands' services. The results of a valuation estimated the average value of the wetlands' water treatment service to be US$ 12,385/ha annually." (TEEB 2011; TEEBcase by Turpie J. 2010).
- **Case 6:** «The Greater City of Kampala benefits from services provided by the Nakivubo Swamp (catchment area >40km^2) which cleans water polluted by industrial, urban and untreated sewage waste. A valuation study looked at the cost of replacing wetland wastewater processing services with artificial technologies (i.e. upgraded sewage treatment plant, construction of latrines to process sewage from nearby slums). It concluded that the infrastructure required to achieve a similar level of wastewater treatment to that naturally provided by the wetland would cost up to US$2 million/year compared to the costs of managing the natural wetland to optimize its waste treatment potential and maintain its ecological integrity (about US$ 235,000). On the basis of this economic argument, plans to drain and reclaim the wetland were reversed and Nakivubo was legally designated as part of the city's greenbelt zone." (from TEEB 2011; Emerton and Bos (2004); TNC (2007); UNDP-UNEP Poverty-Environment Facility (2008); TEEBcase by K. Almack mainly based on Emerton et al. 1999).

Investments in nature to reduce flooding impacts

- **Case 7:** In Belgium, to meet flood risk minimisation objectives in the Scheldt estuary, the Dutch and Flemish governments approved an integrated management plan consisting of the restoration of approximately 5500ha, dike reinforcement and dredging. This solution was chosen as it had an estimated payback of 14 years; the payback with the storm surge barrier was 41 years. (De Nocker et al 2004, Meire et al. 2005, Broekx et al. 2010).
- **Case 8:** In Sri Lanka, flood attenuation provided by the 7000ha Muthurajawella Marsh near Colombo has been valued at over US$5 million/ year (Schuyt and Brander, 2004; TEEB 2012b).
- **Case 9:** In China, following severe Yangtze River flooding in 1999, the government committed to invest over US$40 billion in the Sloping Land Conversion Programme to allow for reforestation along the river to decrease erosion and mitigate flood impacts (Bennett and Xu, 2007; Tallis et al. 2008).

Wetlands delivering multiple benefits

- **Case 10:** In Mecklenburg-Vorpommern, Germany, 30,000 hectares of peatland were restored over the period 2000 to 2008, leading to emission savings

of up to 300,000 t CO2-equivalent at an avoidance cost of CO2 ~ 8 to 12 €/t CO2. If alternative land use options are realized (extensive grazing, reed production or alder forest growth) costs can decrease to 0 to 4 € / t CO2.; (TEEBcase by J. Förster mainly based on MLUV 2009 and Schäfer et al. 2009).

- **Case 11:** "The Mississippi River Delta ecosystems provide at least $12-47 billion in benefits to people every year. If this natural capital were treated as an economic asset, the delta's minimum asset value would be $330 billion to $1.3 trillion (3.5% discount rate). The goods and ecosystem services valued in this study include hurricane and flood protection, water supply, water quality, recreation and fisheries." (Earth Economics 2010).
- **Case 12:** «The Manalana wetland (near Bushbuckridge, Mpumalanga, South Africa) was severely degraded by erosion that threatened to consume the entire system if left unchecked. The wetland supports around 100 small-scale farmers, 98 of whom are women. Approximately 70 per cent of local people make use of the wetland in some way, with about 25 per cent depending on it as their sole source of food and income. The wetland was thus considered to offer an important safety net, particularly for the poor, contributing about 40 per cent of locally grown food. An economic valuation study completed in 2008 revealed that:
- the value of livelihood benefits derived from the degraded wetland was just 34 per cent of what could be achieved after investment in ecosystem rehabilitation;
- the rehabilitated wetland now contributes provisioning services conservatively estimated at a net return, i.e. after making provision for costs, of €297/household per year;
- the total economic value of the livelihood benefits (€182,000) provided by the rehabilitated wetland is more than twice what it cost to undertake the rehabilitation works (€86,000), indicating a worthwhile return on investment by 'Working for Wetlands';
- the Manalana wetland acted as a safety net that buffered households from slipping further into poverty during times of shock or stress." (TEEB 2011)
- **Case 13:** "One study found that the abandoned mangrove ecosystems can be rehabilitated at a cost of US$8240 per hectare in the first year (replanting mangroves) followed by annual costs of US$118 per hectare for maintenance and protecting of seedlings (Sathirathai and Barbier, 2001, p119). Benefits from the restoration project comprise the estimated net income from collected forest products of US$101 per hectare/year, estimated benefits from habitat–fishery linkages (mainly the functioning of mangroves as fish nursery) worth US$171 per hectare/year and estimated benefits from storm protection worth US$1879 per hectare/year (Barbier, 2007, p211)." (TEEB 2011)

Impacts of the loss of wetlands and water-related ecosystems on human well-being and biodiversity

- **Case 14:** "In the early sixties the Government of the former Soviet Union decided to intensify and expand its irrigation activities in Central Asia. The result has been shrinking and salination of the Aral Sea and reduced availability of water in the deltas of these two rivers, considerable loss of biodiversity, vegetation and fisheries, the occurrence of salt and dust-laden winds and the deteriorating health conditions because of salination of groundwater." (From TEEB 2011; TEEBcase by R. Slootweg 2010).
- **Case 15:** In Vietnam, following typhoon Wukong in 2000, areas planted with mangroves remained relatively unharmed while neighbouring provinces suffered significant losses of life and property (Brown et al, 2006 in TEEB 2011).
- **Case 16:** "The Waza floodplain (8000km^2) is a high-productivity area and critical for biodiversity maintenance in Cameroon. Around 125,000 people depend on services provided by this floodplain ecosystem for their subsistence livelihoods, and the floodplain in turn depends to a large extent on annual flooding of the Logone River. In 1979, construction of a large irrigated rice scheme reduced flooding by almost 1000km^2 which had devastating effects on the region's ecosystems, biodiversity and human populations (UNDP-UNEP Poverty-Environment Initiative, 2008). Engineering works to reinstate the flooding regime have the potential to restore up to 90 per cent of the floodplain area at an estimated capital cost of approximately US$11 million (Loth, 2004). The same study found the socio-economic effects of flood loss to be significant, incurring livelihood costs of almost US$50 million over the 20 years since the scheme was constructed. Local households suffer direct economic losses of more than US$2 million/year through reduced dry season grazing, fishing, natural resource harvesting and surface water supplies. The affected population, mainly pastoralists, fishers and dryland farmers, represent some of the poorest and most vulnerable groups in the region." (From TEEB 2011).


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