Managing Coastal Marine Biodiversity and Protected Areas

For MPA managers

Module 2

Coastal and Marine Ecosystem Services and their Value

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On behalf of:

Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety

of the Federal Republic of Germany

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Summary

This module facilitates participants looking into the concept of ecosystem services, overall development agenda via Global Sustainable Development Goals, the concept of sustainability, the concept of sustainable livelihoods and its interlinkages with the ecosystem services. The module then takes a deeper look into the economic values, and threats to coastal and marine biodiversity and focuses in detail on the climate change and disaster aspects and their interrelationship with the coastal and marine biodiversity conservation

Key Messages

- Coastal and Marine ecosystems provide a wide range of services to human society including supporting, regulating, cultural and provisioning services.
- These services influence human welfare both directly, through human use, and indirectly, via impacts on supporting and regulating services in other environments. But they are increasingly under threat from widespread and growing pressures on marine and coastal resources such as overfishing, water contamination, coastal habitat destruction, and general loss of biodiversity.
- The consequences of the biodiversity loss and resulting loss of ecosystem services has far reaching impact on livelihoods and the overall wellbeing of human communities.
- Valuation can be useful and/or relevant at all levels of governance, including strategic policy setting, project appraisals, decision making, day to day management, and communication with stakeholders.

2.1 Why is Biodiversity Important?

Ecosystem services: provisioning, regulating, supporting and cultural ecosystem services

The Millennium Ecosystem Assessment of 20059 (MEA) defines ecosystem services as the benefits people obtain from ecosystems. They illustrate the link between interactions of species with each other and the physical envi- ronment, as well as the usefulness of these functions for the well-being of people, in terms of wealth, nutrition and security. Ecosystems provide a variety of benefits to people, including provisioning, regulating, cultural, and supporting services

2.1.1 Provisioning services

Provisioning services are the products people obtain from ecosystems, such as food (agriculture and horticulture crops, livestock, fish), medicinal and aromatic plants and products, fuel, fibre, fresh water, gums and resins, minerals and genetic resources.

Fish (including shellfish) provides essential nutrition for three billion people and at least 50 per cent of animal protein and minerals to 400 million people in the poorest countries.

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2.1.2 Regulating services

Regulating services are the benefits people obtain from regulation of ecosystem processes, including air quality maintenance, climate regulation, carbon sequestration, regulation of human diseases, plant pest and disease control, water purification, natural hazard and disaster risk reduction (mitigating the threat from landslides, floods and even tsunamis), pollination etc. 55% of atmospheric carbon emanating from living organisms is captured by marine organisms, and of this between 50-71% is captured by the ocean's vegetated habitats (e.g. mangroves, salt marshes, seagrasses) which cover less than 0.5% of the seabed.

2.1.3 Cultural services

Cultural services are the nonmaterial benefits people obtain from ecosystems such as spiritual enrichment, religious and cultural value (sacred sites), knowledge systems, educational values, aesthetic values, social relations (in urban green spaces), and recreation and ecotourism. Spiritual and religious value refers to religious bonds to sacred landscapes, groves and species (Butler, 2006) which is often connected to different religions. For example, the Khecheopalri Lake in Sikkim in northeast India, is considered to be sacred both by Buddhists and the Hindus of Sikkim . The World Heritage Convention acknowledges ecosystem services provided by cultural landscapes.

These are the nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences

2.1.4 Supporting services

Supporting services are those that are necessary for the production of all other ecosystem services, such as biomass production, production of atmospheric oxygen, soil formation and retention, nutrient cycling, water cycling, and provisioning of the habitat. A very prominent example for this type of service is the value of an intact forest in the vicinity of agriculture fields, which provides soil nutrients and maintains soil productivity of the agriculture field.

Supporting services are those that are necessary for the production of all other ecosystem services. They differ from provisioning, regulating, and cultural services in that their impacts on people are often indirect or occur over a very long time, whereas changes in the other categories have relatively direct and short-term impacts on people. (Some services, like erosion regulation, can be categorised as both a supporting and a regulating service, depending on the time scale and immediacy of their impact on people).

2.2 Overall development scenario:

The eight Millennium Development Goals (MDGs) – which range from halving extreme poverty to halting the spread of HIV/AIDS and providing universal primary education, all by the target date of 2015 – form a blueprint agreed to by all UN member countries and all leading development institutions of the world. MDGs have galvanised unprecedented efforts on a global scale to meet the needs of the world's poorest.

The MDGs have been replaced by the Sustainable Development Goals from 2015. At the Rio+20 meeting, two decades after the Earth Summit in Rio de Janeiro in 1992, it was decided to institute Sustainable Development Goals (SDGs) from 2015. Targets for achieving these goals have been set for either 2020 or 2030. Eradicating poverty was, once again, seen as the greatest challenge to humankind. Changing unsustainable patterns of production and consumption and promoting sustainable ones were major priorities, and managing the natural resource base was seen as essential to achieving such sustainable practices.

What are the proposed 17 SDG goals?

1. End poverty in all its forms everywhere
2. End hunger, achieve food security and improved nutrition, and promote sustainable agriculture
3. Ensure healthy lives and promote wellbeing for all at all ages
4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
5. Achieve gender equality and empower all women and girls
6. Ensure availability and sustainable management of water and sanitation for all
7. Ensure access to affordable, reliable, sustainable and modern energy for all
8. Promote sustained, inclusive and sustainable economic growth, full and productive employment, and decent work for all
9. Build resilient infrastructure, promote inclusive and sustainable industrialisation, and foster innovation

10. Reduce inequality within and among countries
11. Make cities and human settlements inclusive, safe, resilient and sustainable
12. Ensure sustainable consumption and production patterns
13. Take urgent action to combat climate change and its impacts (taking note of agreements made by the UNFCCC forum)
14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development
15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertifi cation and halt and reverse land degradation, and halt biodiversity loss
16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
17. Strengthen the means of implementation and revitalise the global partnership for sustainable development

It is estimated that nearly 250 million people live within a swathe of 50 km from the coastline of India who are dependent on the rich coastal and marine resources. Therefore, the ecological services of the marine and coastal ecosystems of India play a vital role in India's economic growth and the welfare of citizens.

Today, human activities are threatening the seas and coasts through overfishing, destructive fishing practices, pollution and waste disposal, agricultural runoff, invasive alien species and habitat destruction. Global climate change will make it worse. Sea levels are already rising and will rise further, water temperature will increase, oceans will acidify, and there will be more storms and natural disasters of a severe nature.

India is one among 12 mega-biodiversity countries and 25 biodiversity hotspots of the richest and highly endangered eco-regions of the world.

2.3 Status of ecosystem services

Approximately 60 per cent (15 out of 24) of the ecosystem services evaluated in the Millennium Ecosystem Assessment (including 70 per cent of regulating and cultural services) are being degraded or used unsustainably. Loss of biodiversity, in terms of habitat, species and genetic diversity, is enormous.

The ecosystem services that have been degraded over the past 50 years include capture fisheries, water supply, waste treatment and detoxification, water purification, natural hazard protection, regulation of air quality, regulation of regional and local climate, regulation of soil erosion, spiritual fulfillment, and aesthetic enjoyment. The use of two ecosystem services – capture and fresh water fisheries – is now well beyond levels that can be sustained even at current demands, much less future ones. At least one quarter of important commercial fish stocks are overharvested (high certainty). The quantity of fish caught by humans increased until the 1980s but is now declining because of the shortage of stocks.

According to UNEP reports, FROM 5 per cent to possibly 25 per cent of global freshwater use exceeds long-term accessible supplies. It is now met either through engineered water transfers or overdraft of groundwater supplies (low to medium certainty). Some 15-35 per cent of irrigation withdrawals exceeds supply rates and are therefore unsustainable (low to medium certainty).

Of the 24 ecosystem services, only 4 have been enhanced in the past 50 years, three of which involve food production — crops, livestock, and aquaculture. Terrestrial ecosystems were on average a net source of CO2 emissions during the 19th and early 20th centuries due to widespread deforestation, but became a net sink around the mid- dle of the last century due to reforestation efforts. Thus, in the last 50 years, the role of ecosystems in regulating global climate through carbon sequestration has also been enhanced.

Many marine and coastal ecosystems no longer deliver the full suite of ecosystem services upon which humans have come to rely (Mengerink et al 2009) due to trade-offs between the activities of different sectors. Trade-offs can be minimised if the primary goal of all the activities in the marine and coastal ecosystems is maintaining a sustainable flow of ecosystem services (Rosenberg 2005; Millennium Ecosystem Assessment 2005).

From time immemorial human beings have been drawn towards nature and its services. But now we are at a stage of evolution where the current rate of extinction of species has surpassed all records in history. One of the main reasons cited is the unwise use or exploitation of nature

The consequences of the biodiversity loss and resulting loss of ecosystem services has far reaching impact on livelihoods and the overall wellbeing of human communities

2.4 Human well-being, ecosystem services and livelihood

2.4.1 What is sustainable livelihood?

A livelihood is sustainable and secure when:

- it can cope with and recover from stress and shocks,
- maintain or enhance its capabilities and assets, and
- provide sustainable livelihood opportunities for the next generation.

It contributes net benefits to other livelihoods at the local and global levels and in the short and long term.

A livelihood is environmentally sustainable when the natural resources and ecosystem services are being utilized for livelihood activities at a rate and in a manner that do not pose any threats to the natural ecosystems and the ecosystem services. The livelihood is socially sustainable, when it is able to cope with stress (declining resources, climate variability) and shocks (natural disasters), and retain its ability to continue and improve, or in other terms, when it is less vulnerable to the stresses and shocks.

Both aspects of livelihood sustainability – social and environmental – are fundamentally affected by the type, amount and sustainability of the ecosystem services. The consequences of biodiversity loss and ecosystem disruption, therefore, are often harshest for the rural poor, who are highly dependent on local ecosystem services for their livelihood and who are often the least able to access or afford substitutes when these become degraded. These impacts are highest in mountain and coastal communities; these ecosystems are also one of the most vulnerable as far as the negative impacts of climate change are concerned. In fact, the Millennium Ecosystem Assessment has confirmed that biodiversity loss poses a significant barrier to meeting the needs of the world's poorest, as set out in the United Nations Millennium Development Goals

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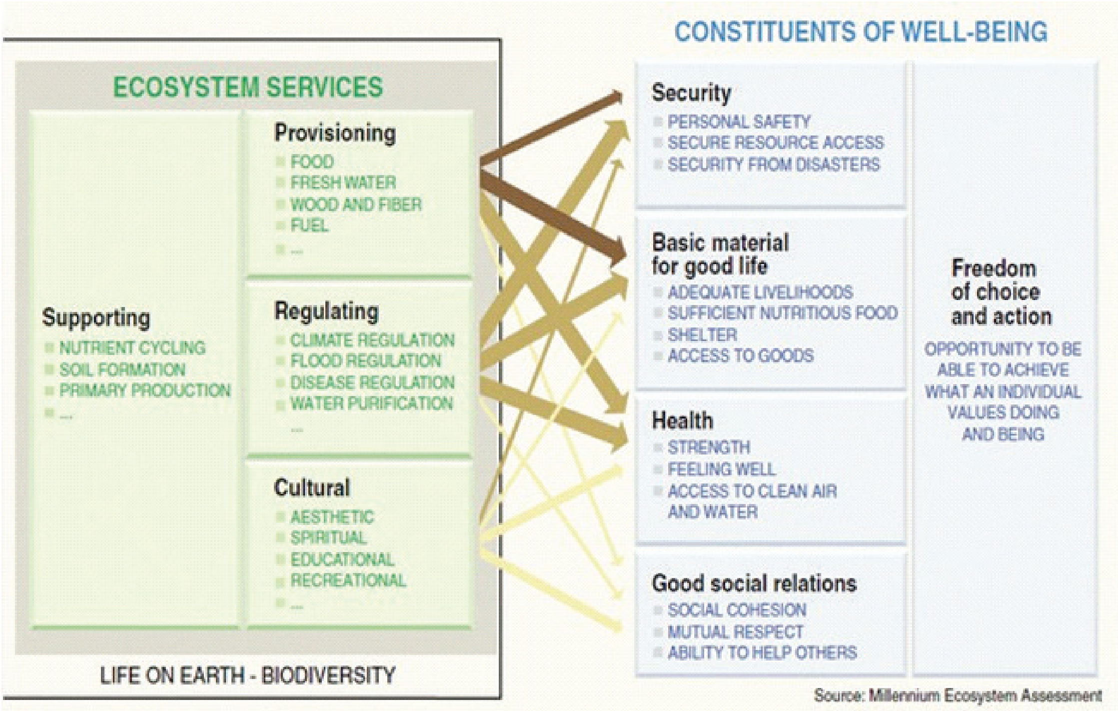
2.4.2 Overall human well-being and its dependence on ecosystem services

The Millennium Ecosystems Assessment uses the concept of well-being, which is far more inclusive than livelihood (Figure 1).

The consequences of the biodiversity loss and resulting loss of ecosystem services has far reaching impact on livelihoods and overall wellbeing of human communities. Human well-being has multiple constituents, including basic material for a good life, freedom and choice, health, good social relations, and security. Well-being is at the opposite end of a continuum from poverty, which has been defined as a "pronounced deprivation in well-being."The constituents of well-being, as experienced and perceived by people, are situation-dependent, reflecting local geography, culture, and ecological circumstances.

Figure 1: Ecosystems and overall well-being of the human population



2.5 Putting a value on biodiversity and ecosystem services:

2.5.1 Why put a value on coastal and marine biodiversity and ecosystem services?

The principal means for communicating the consequences of ecological change for human wellbeing is to document the impacts on ecosystem services. This improves understanding of the importance to humans of coastal and marine ecosystems, informs decision making processes, and supports attempts to influence human behaviour. Impacts on ecosystem services can be examined in qualitative terms, by quantitative measurements, or through economic valuation.

Valuing ecosystem services would provide policy-makers with a strong rationale to improve coastal and marine ecosystem management and invest in conservation for its risk management value and economic benefits. In order to fully leverage ecological and economic knowledge of ecosystems and services, there is a need to generate and provide access to better data regarding ecosystem services.

Economic valuation seeks to quantify the ways in which ecosystem services provide benefits to human populations, and expresses these values in monetary units that can be compared with other sources of value to society

Measurement of ecosystem services and their values to humans is rapidly becoming the principal means for communicating the impacts of ecological change on human well-being.

The ultimate aims of defining and measuring the value of the natural environment are to better inform management choices, and/or influence human behaviour. There are two main types of reason for valuing ecosystem services:

- To assess the costs and benefits of an action or policy, as an aid to decision making;
- To improve understanding of the value of benefits to society from an ecosystem or series of linked ecosystems.
- Ecosystem valuation can assist in a wide range of tasks, including: z Demonstrating and communicating the importance of an ecosystem;
- Guiding national development plans;

- Policy, programme and project appraisal;
- Setting priorities within a sector plan or across different sectors;
- Green national and corporate accounting;
- Setting a framework to establish market based instruments such as taxes, charges, fees, fines, penalties, subsidies and incentives and tradable permit schemes;
- Determining liability and compensation in environmental litigation.

The choice of valuation method used in a practical situation can depend on governance scale, decision context, scientific understanding, and various other factors.

2.5.2 What are the values of coastal and marine biodiversity and ecosystem services?

Marine and coastal resources provide millions of impoverished people across the globe with livelihoods and range of critical ecosystem services like biodiversity, culture to carbon storage to flood protection. Coastal and marine ecosystems are among the most productive ecosystems in the word, provide many services to human society and are of great economic value (UNEP, 2006). The Indian coasts support about 30% of the total 1.2 billion human populations. (TII, 2014).

DIRECT USE VALUES

Direct use values refer to ecosystem goods and services that are used directly by humans. These include the value of consumptive uses such as harvesting of food products, timber for fuel or construction, and medicinal products and hunting of animals for consumption, and the value of non-consumptive uses such as the enjoyment of recrea- tional and cultural activities that do not require harvesting of products. Direct use values are most often enjoyed by people visiting or residing in the ecosystem itself.

INDIRECT USE VALUES

Indirect use values are derived from ecosystem services that provide benefits outside the ecosystem itself. Examples include natural water filtration which often benefits people far downstream, the storm protection function of mangrove forests which benefits costal properties and infrastructure, and carbon sequestration which benefits the entire global community by abating climate change.

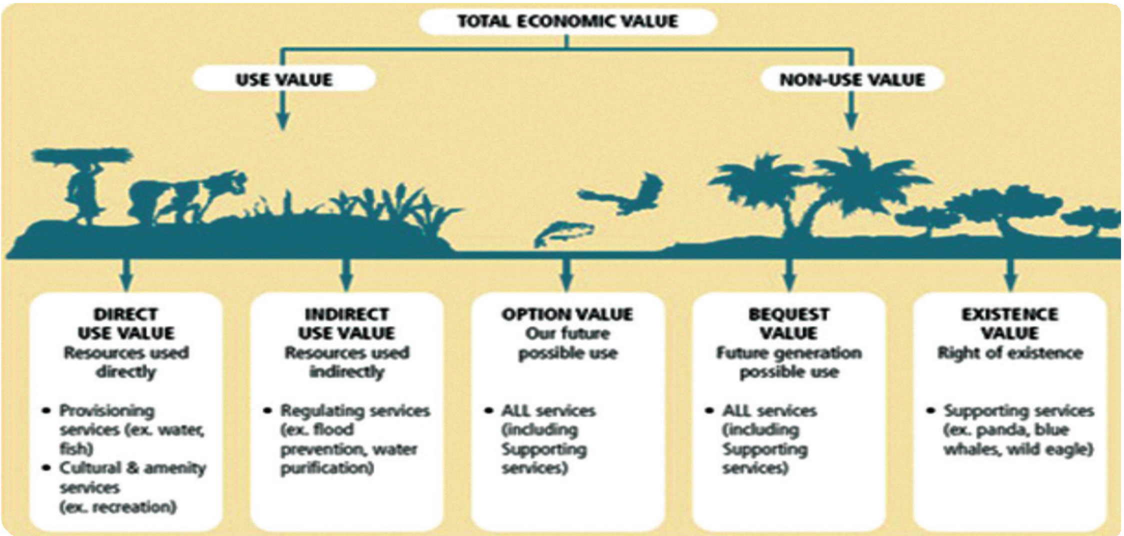
OPTION VALUES

Option values are derived from preserving the option to use in the future ecosystem goods and services that may not be used at present, either by oneself (option value) or by others/heirs (bequest value). Provisioning, regulating, and cultural services may all form part of option value to the extent that they are not used now but may be used in the future.

NON-USE VALUES

Non-use values refer to the enjoyment people may experience simply by knowing that a resource exists even if they never expect to use that resource directly themselves. This kind of value is usually known as existence value (or, sometimes, passive use value).

Figure 1: Ecosystem goods and services and their value



2.5.3 Valuation methods and examples

Economic valuation offers a way to compare the diverse benefits and costs associated with ecosystems by attempt- ing to measure them and expressing them in a common denominator — typically a monetary unit. The main framework used is the Total Economic Value (TEV) approach. The breakdown and terminology vary slightly from analyst to analyst, but generally include (i) direct use value, (ii) indirect use value, (iii) option value, and (iv) non-use value. The first three are generally referred to together as 'use value'.

Environmental valuation is largely based on the assumption that individuals are willing to pay for environmental gains and, conversely, are willing to accept compensation for some environmental losses. The individual demonstrates preferences, which, in turn, place values on environmental resources. That society values environmental resources is certain; monetising the value placed on changes in environmental assets such as coastal areas and water quality is far more complex. Environmental economists have developed a number of market and non- market-based techniques to value the environment.

Bohol Marine Triangle Economic Valuation

On the question of whether to sustain the use of natural resources in the Bohol Marine Triangle (BMT) in the Philippines, a study was proposed to understand the economic benefits generated from coastal and marine habitats and ecosystems there. The study combined market-based valuation of economic activities (fisheries, tourism, gleaning, and seaweed farming) and value transfer methods for non-marketed impacts (biodiversity conservation, flood protection, fish nursery function). The accumulated total net benefit for the BMT natural resources over a 10-year period was found to be US$11.54 million (with a 10% discount rate).This led to officials in allocat- ing resources for maintaining the ecosystems of BMT.

Decision-making in the Stockholm archipelago

The decision-makers faced with the specific issue of eutrophication (loss of dissolved oxygen in the water, due to high organic content) in the Stockholm archipelago. They carried out the analysis of the benefits and costs of reducing eutrophication. For this evaluation, it was assumed that a reduction in eutrophication would lead to an increase in water transparency, which would increase both ecological health and human enjoyment of the area. It was also assumed that a 40 per cent reduction in nitrogen load was needed to achieve a one-metre increase in transparency, through a combination of measures, including increased sewage water treatment and reduced fertiliser use.

The total costs of such measures were estimated to be Swedish Kroner (SEK) 57 million per year. The benefits of the reduction of eutrophication were estimated to be about SEK 60 million per year for recreational benefits (travel cost method) and SEK 500 million per year for all conservation benefits (contingent valuation method). However, the analysis indicates that the costs of reducing eutrophication could be justified purely by the recrea- tion values and that when taking a full range of values into account the benefits could outweigh the costs by a ratio of 8:1 or more.

There are three families of valuation techniques: market based techniques, revealed preference and stated preference.

2.5.3.1 MARKET-BASED TECHNIQUES

These use evidence from markets in which environmental goods and services are traded, markets in which they enter into the production functions for traded goods and services, or markets for substitutes or alternative re- sources.

Example: *To understand the economic benefits generated from coastal and marine habitats and ecosystems in Bohol Marine Triangle (BMT) in the Philippines as a basis for sustaining the use of natural resources in the area. BMT area has rich biodiversity and the local community is dependent on the coastal and marine resources of the area. The study combined market-based valuation of economic activities (fisheries, tourism, gleaning, and seaweed farming) and value transfer methods for non-marketed impacts (biodiversity conservation, flood protection, fish nursery function). The* *accumulated total net benefit for the BMT natural resources over a 10-year period was found to be US$11.54 million (with a 10% discount rate).*

2.5.3.2 REVEALED PREFERENCE METHODS

These are based on deducing the value of ecosystem services by interpreting observed human behaviour.

Example: *The decision-makers were faced with the issue of eutrophication in the Stockholm archipelago. They car- ried out the analysis of the benefits and costs of reducing the eutrophication in the Stockholm archipelago. For this evaluation, it was assumed that a reduction in eutrophication would lead to an increase in water transparency, which would increase both ecological health and human enjoyment of the area. It was also assumed that a 40 per cent reduction in nitrogen load was needed to achieve a one-metre increase in transparency, through a combination of measures including increased sewage water treatment and reduced fertilizer use. The total costs of such measures were estimated to be SEK 57 million per year. The benefits of the reduction of eutrophication were estimated to be about SEK 60 million per year for recreational benefits (travel cost method) and SEK 500 million per year for all conservation benefits (contingent valuation method). However, the analysis indicates that the costs of reducing eu- trophication could be justified purely by the recreation values and that when taking a full range of values into account the benefits could outweigh the costs by a ratio of 8:1 or more.*

2.5.3.3 STATED PREFERENCE TECHNIQUES

These methods are based on surveys in which people give valuation responses in hypothetical situations. Some of the popular valuation methods are contingent valuation, choice experiments, value transfer.

2.5.4 Case studies on Economic Valuation of Coastal and Marine Biodiversity

2.5.4.1 MANGROVES OF THAILAND

Ecosystem services: food production, wood products, coastal protection and fish nurseries

Valuation method: market and production function approaches

Implications: mangrove conservation is more beneficial than conversion for shrimp farms, but if non-linearities are taken into account, limited conversion for shrimp farming has relatively little impact on coastal protection

Barbier et al. (2008) demonstrate the practical importance of taking into account non-linear relationships between value and area. They show that using an average value for the storm protection value of mangroves in an area of Thailand ($1879 per ha), mangrove conservation clearly dominates conversion for shrimp farms. However, using the marginal values, and therefore taking into account that small reductions in mangrove area have relatively limited impact on flood protection values, this result is nuanced: the highest values overall occur if there is, in this case, 20% mangrove conversion for shrimp farms, and 80% conservation. Of course there is a strong spatial component to the value – the flood defence value of any given hectare depends strongly on where it is and what people and infrastructure it protects, as well as on the extent of mangrove nearby: the 20% earmarked for conversion should be carefully chosen to incur the smallest reduction in coastal protection values. Taking non-linear values into account is also very important in determining the appropriate level of mangrove restoration where they have already been destroyed. Barbier (2009) reports restoration costs with a present value of around $9000 per ha. Considering the average value of flood protection (present value around $11000 per ha) would suggest that restoration is profitable. Looking at marginal values would reveal the more accurate conclusion that it is profitable up to a point. This reasoning can help ensure that scarce resources for restoration and conservation activities are optimally allocated.

2.5.4.2 VALUATION FOR GUINEA CURRENT LARGE MARINE ECOSYSTEM

Ecosystem services: range of the most important services (see below)

Valuation method: market and value transfer approaches

Implications: demonstration of major benefits from the marine ecosystem accruing to human populations

The Guinea Current Large Marine Ecosystem (GCLME) valuation project (Interwies, 2010) aimed to develop an initial assessment of the costs and benefits deriving from conservation at the large scale of an entire LME. The 16 GCLME countries face issues of unsustainable fisheries and marine resource management generally, and degradation of marine and coastal ecosystems by human activities. To combat the resulting environmental and social problems, environmental and sustainability concerns must be integrated into policies and decision making, and economic valuation of ecosystem services is one important step towards this. Given time and resource pressures, the benefits of the using a value transfer approach were considered to outweigh the costs of possible inaccuracies in this approach. The valuation is based on the current flow of ecosystem services, raising awareness of current flows and providing the background and motivation for conservation initiatives and specific policy options (which may require separate, more detailed cost benefit calculations).

Ecosystem services valued in the study include:

- Fisheries
- Fish nurseries
- Tourism
- Timber and non-timber forest products
- Flood and erosion control
- Sewage treatment
- Drinking water
- Carbon sequestration
- Biodiversity and other non-use

Overall, the 253 million hectare area is estimated to yield annual benefits of $14 billion from marine environments (mostly from fisheries) and $3.5 billion from coastal environments (mostly fish nurseries, coastal protection and tourism). The estimates are used to demonstrate the importance of the marine and coastal environment to the human populations living around it, feeding in to work on policy instruments for conservation and resource management. In addition to the aggregate value estimates, some headline calculations are presented with clear policy relevance: for example, it is estimated that one hectare of destroyed mangrove ecosystem in the GCLME represents losses of US$32,000 (4% discount rate) to US$38,000 (3% discount rate).

2.5.4.3 VALUATION FOR THE 'PLAN BLEU' IN THE MEDITERRANEAN

Ecosystem services: six key services (see below)

Valuation method: value added, avoided cost, value transfer

Implications: demonstration of important benefits, and their distribution across countries, and also of data gaps

High levels of exploitation and other human activities, coupled with climate change, are threatening sensitive biodiversity and habitats in the Mediterranean. In addition to conservation concerns, the human and economic costs are potentially very significant. To illustrate this, the Plan Bleu has carried out research to establish a first estimation of the annual value of economic benefits flowing from the whole Mediterranean marine environment. Six types of marine ecosystems were studied, each characterised by the biodiversity and surface they cover and the ecological services they provide. The economic valuation of the benefits those ecosystems provide focused on six ecological services: production of food resources, amenities, support to recreational activities, climate regulation, mitigation of natural risks and waste assimilation.

At the regional level, the aggregate value amounted to over €26 billion in 2005; an average of about €10,000 per square km per year, though this varies significantly across different habitats and areas. And, due to a lack of data, the value of benefits from ecological services provided by marine ecosystems in the Mediterranean was probably underestimated. The distribution of the value by benefit types shows that 68% of benefits would come from the provision of amenities and recreational support (€18 billion). The distribution of the value of benefits by country shows that 8 countries would capture about 90% of the value of benefits provided by marine ecosystems: Italy, Spain, Greece, France, Turkey, Israel, Egypt and Algeria.

2.5.4.4 VALUATION AND COST-BENEFIT ANALYSIS FOR THE BLACKWATER ESTUARY

Ecosystem services: several specific services and a composite 'environmental quality' benefit

Valuation method: market, production function and stated preference, in cost-benefit framework

Implications: the benefits of managed realignment scenarios exceed costs when non-market ecosystem service values are taken into account.

Luisetti (2008) applies CBA methods to assess four different options for the Blackwater Estuary in East England, with varying levels of managed realignment and habitat creation: 'hold the line', 'policy targets' (PT) (meeting existing targets), 'deep green' (DG), 'extended deep green' (EDG). Market prices are used to value coastal defence work (costs avoided), fisheries (modelled via a production function), and agricultural land lost (after adjustment for subsidies). Three carbon price estimates are used for the carbon, methane and nitrous oxide fluxes. A stated preference study is used for a "composite environmental benefit" that is intended to cover a wide range of impacts without double-counting: recreation, aesthetics, water quality, and biodiversity. The study breaks total value down into use and non-use components, and the aggregation methods allowed for distance-decay and nonlinear relationship with wetland area. Thus the estimates for the composite environmental benefit showed the diminishing marginal value of provision of additional areas of high environmental quality: in the PT scenario (81.6ha wetlands) the value estimate is £6.3m/yr of which £4.4 is use value; in the DG scenario, with 10 times more wetlands, the value is only a little higher at £7.7m/yr, of which £5.8m is use value, while in the EDG scenario, with 30 times more wetland than PT, value is £8.3m/yr of which £6.4m is use value. Results of the CBA show that managed realignment can be cost-beneficial if non-marketed benefits are accounted for, particularly for conservation and recreation. With a constant 3.5% discount rate, the highest NPV is the "deep green" scenario (£106m over 25 years, £192m over 100 years); much higher values arise using a declining discount rate, making the "extended deep green" scenario preferable (because the lower discounting of long-term future makes it easier for long-term environmental benefits to outweigh near-term costs). The study is well grounded in scientific analyses of fisheries and sediment transport, and is exemplary in exploring sensitivities to different time horizons, discount rates, values and assumptions

2.5.4.5 EUTROPHICATION REDUCTION IN THE STOCKHOLM ARCHIPELAGO

Ecosystem services: recreation, general benefits of conservation

Valuation methods: market costs of measures, benefits estimated through travel cost and stated preference **Implications:** in this case, benefits of a management intervention significantly exceed costs, but this is location-specific

Söderqvist et al. (2004) present an analysis of the benefits and costs of reducing eutrophication in the Stockholm archipelago (see also 'cost-benefit analysis', p. 28). For this evaluation, it was assumed that a reduction in eutrophication would lead to an increase in water transparency, which would increase both ecological health and human enjoyment of the area. It was also assumed that a 40 per cent reduction in nitrogen load was needed to achieve a one-metre increase in transparency, through a combination of measures including increased sewage water treatment and reduced fertilizer use. The total costs of such measures were estimated to be SEK 57 million per year. The benefits of the reduction of eutrophication were estimated to be about SEK 60 million per year for recreational benefits (travel cost method) and SEK 500 million per year for all conservation benefits (contingent valuation method).

There is a risk of double-counting if the results of the travel cost valuation (which accounts only for recreation values) are combined with the contingent valuation (which accounts for a wider range of values, including non-use, but could also cover recreation). However, the analysis indicates that the costs of reducing eutrophication could be justified purely by the recreation values, and that when taking a full range of values into account the benefits could outweigh the costs by a ratio of 8:1 or more. This is very useful information for decision makers faced with the specific issue of eutrophication in the archipelago. However, it should also be noted that the location near the capital city means the use values are going to be much higher than in less populated regions, so this result could not simply be transferred to other parts of the Baltic.

2.5.4.6 WADDEN SEA ESTIMATES OF EXPENDITURE

Ecosystem services: recreation and tourism

Valuation methods: expenditure and employment (not estimates of TEV)

Implications: demonstrates importance of national park tourism to local/regional economy

WWF (2008) reports on the Wadden Sea National Park as an example of a tourist-based economy, with over 10 million tourists per year. They stress the added value arising through tourists' additional expenditures, stating that tourists who visit the area purely because of the National Park generate a regional added value of about US$ 5,050,000, corresponding to 280 full time jobs. Furthermore, tourists for whom the national park plays an important (but not exclusive) role in their choice of destination generated added value of US$131,000,000 or about 5.900 full time jobs. However, these expenditures are related to the National Park as a whole, and it is difficult to determine the extent to which specific marine ecosystems services and/or aspects of biodiversity influence tourists' decisions.

2.5.5 Applicability of valuation methods to coastal and marine ecosystem services:

Valuation method	Value captured	Points to note	Ecosystem services
Market based approaches: based on market prices and other data			
Market prices	Direct use values	Adjust for costs, subsidies, taxes	Provisioning services, provided these are marketed, e.g. fisheries, aquaculture, renewable energy, aggregates, fossil fuels
Market proxies	Direct use values	Adjust for costs, subsidies, taxes	Where a service is not marketed, one can sometimes use a proxy market value: for example, valuing subsistence fishing at the market value of fish
Production functions	Use values	Data hungry	For example, nursery habitat for fisheries is often valued via a production function
Cost of illness	Varies depending on how health impact is valued	Production function linking change to health impact	Any ecosystem change that impacts on human health or mortality (e.g. wastewater treatment)
Avoided costs	Cost, not value	Presumes replacement would be appropriate	For example, the cost of recreating coastal wetlands to compensate for losses
Revealed preference methods: based on actual behaviour			
Hedonic property pricing	Use values within home	Depends on awareness of impacts	Seascapes, amenities, peace and quiet, general environmental quality
Travel cost	Use values for recreation	Based on visits to a site	Recreation and ecosystem services that contribute to it
Random utility model	Use values for recreation	Based on choice among sites	Recreation and ecosystem services that contribute to it
Stated preference methods: based on hypothetical behaviour			
Contingent valuation	All use and non-use	Based on pricing single option	All services. The only methods able to estimate non-use values. Often used for biodiversity, cultural and heritage values
Choice modelling	All use and non-use	Based on choice from options	Same as for "contingent valuation"

Besides the well-known economic value of fisheries, there are several other **activities generating significant revenues** in coastal and marine areas. **Tourism** has become one of the world's fastest growing industries, providing a significant proportion of the GDPs of many developing countries. Small island states are particularly reliant on coastal and marine tourism. In the Caribbean, for example, the industry accounts for a quarter of the total economy, and a fifth of all jobs. However, the very areas that attract tourists are also coming under increasing pressure from the damage and pollution caused by tourist facilities and the supporting infrastructure (GESAMP, 2001a).

The world's oceans also provide for a global **shipping** industry, which has recorded significant growth in recent years. By 2020, the volume of international trade is expected to have tripled from pre-1995 levels, according to the National Oceanic and Atmospheric Administration (NOAA), with up to 90% of it travelling by sea (McGinn, 1999).

Mining for sand, gravel, coral and minerals has been taking place in shallow waters and continental shelves for decades. Offshore drilling now supplies a substantial proportion of the world's **oil and natural gas**, and the offshore industry is expected to grow significantly in the coming years (Stark & Chew, 2001).

- Although marine products such as seafood, sand and oil have been valued for decades, it is only recently that we have begun to appreciate the oceans' vital services in maintaining ecological diversity and regulating climate.
- A recent calculation, based on more than 100 studies over the past two decades, suggests that ocean services are worth US$23 trillion a year - only slightly less than the world's total GNP.
- It is estimated that the seas and oceans supply two-thirds of the value of all the natural services provided by our natural environment (GESAMP, 2001a).
- Damage caused by the introduction of non-indigenous organisms to coastal and marine environments totals hundreds of millions of US dollars (GESAMP, 2001b).

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