Valuing and conserving ecosystem services: a scoping case study in the Danube Basin

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A report for WWF by

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GLOSSARY

BAP Biodiversity Action Plan

CAP Common Agricultural Policy

CBD Convention on Biological Diversity

DRB Danube River Basin

DRBD Danube River Basin District

EAFRD European Agricultural Fund for Rural Development

EIA Environmental Impact Assessment

EU European Union

HNV High Nature Value

ICPDR International Commission on the Protection of the Danube River

MEA Millennium Ecosystem Assessment

PES Payments for Ecosystem Services

SEA Strategic Environmental Assessment

SOC Soil Organic Carbon

TEEB The Economics of Ecosystems and Biodiversity [study]

TEV Total Economic Value

WFD Water Framework Directive

WTP Willingness To Pay

VALUING AND CONSERVING ECOSYSTEM SERVICES: A SCOPING CASE STUDY IN THE DANUBE BASIN

EXCUTIVE SUMMARY

Aims and scope

Ecosystems provide a wide range of services that are essential for human well being. However, the economic benefits of these services are not widely recognised or captured in markets, which is resulting in ecosystem degradation and the loss of natural capital. Recent initiatives such as the study on The Economics of Ecosystems and Biodiversity (TEEB) have therefore highlighted the importance of better understanding the economic value of ecosystem services and developing instruments to capture and reward these values, thereby encouraging the wiser and sustainable use of our ecosystems.

This study therefore aimed to provide a scoping assessment of how to put the key recommendations of the TEEB initiative into practice, through a case study of ecosystem services in the Danube River Basin (DRB). It primarily demonstrates the potential benefits of an ecosystem-service based approach to land management, whilst also identifying potential constraints and opportunities. Specifically, this study reviewed existing information in order to identify and quantify key ecosystem services in the region, assess their current status, and establish likely future trends in service demand and supply. Further policy measures and information requirements needed to maintain and restore these ecosystems services were then identified and recommendations made for further studies to meet these requirements.

This case study focuses on the DRB as it is an extremely important area for biodiversity, with a diverse range of ecosystems that are know to provide some valuable ecosystem services. It encompasses a wide range of altitudes (from the Austrian Alps to sea level) and includes four of the EU's nine biogeographical regions and therefore has a very wide variety of habitats and associated species. The basin holds some of the most important and largest areas of forest, semi-natural grassland and wetland in Europe, and consequently there are many protected areas of outstanding nature conservation value, such as the Danube Delta.

The DRB is Europe's second largest river basin, covering some 800,000 km², and is home to some 83 million people. It includes the territories of 19 countries, but this study mainly focussed on Austria, Bulgaria, Hungary, Romania, Serbia and Slovakia as each constitute 10% or more of the DRB and more than 25% of their national area occurs within the DRB.

On the basis of available information, and expert judgement, five key types of ecosystem service were selected for assessment on the basis of their known importance in the DRB and the availability of quantitative information on their values. The principle conclusions from the assessments of each key service are outlined below.

River fish production
Although the overall economic value of fisheries in the DRB is relatively low compared to the other ecosystem services assessed below, they do form a significant source of income for some local communities, especially in the Danube Delta. This is despite evidence that fish production has diminished considerably as a result of human activities, including overfishing, pollution and changes to riverine habitats. Without better controls on fishing and river restoration such declines are likely to continue. However, water quality is now improving and this is expected to continue as a result of planned pollution control measures. Furthermore, other fishery recovery measures may become worthwhile given that the demand for fish, such as sturgeon for caviar, is likely to increase. In addition, floodplain wetland habitat restoration measures may arise as a result of initiatives for other ecosystem services such as flood management and storage. Therefore with such actions the importance of fisheries could potentially increase in future.

Water provisioning and purification
All inhabitants of the DRB are directly or indirectly dependent on surface and ground water supplies for domestic needs, as well as a range of other uses such as for industry, farming and the maintenance of river levels for fishing and recreation. Furthermore, it is clear that ecosystems in the region have an important influence on quantity and quality of water resources. In particular, forests and semi-natural habitats that have intact vegetation and soils, and a low nutrient status, play a key role in protecting and improving the quantity and quality of water resources.

Available information suggests that water resources are currently adequate in most regions, although some unsustainable abstraction may be occurring. Such problems may also increase in future as a result of expected rises in demand for water and the impacts of climate change. Although the Danube has moderate to critical levels of organic pollution water quality within the DRB is generally adequate for most uses, although treatment is often required for drinking supplies. Furthermore, pollutant levels are falling and on the basis of planned water pollution control measures, pollution problems are expected to continue to decline. Ongoing increases in forest cover and abandonment of agriculture in areas with steep slopes may also reduce soil erosion problems in the region, thereby increasing the role that ecosystems play in maintaining water quality. However, nutrient pollution could increase if agricultural intensification increases more than is currently predicted.

At the moment we have insufficient scientific information on the relationship between the condition of ecosystems and water resource provision to estimate the added values that various types of ecosystem provide. Moreover, the estimation of the value of water services is further complicated by the fact that water pricing varies considerably amongst the countries of the region and often does not reflect the true costs of its provision (including the economic costs of its environmental impacts).

Flood storage

River impoundments and other engineering works have substantially reduced the area of the Danube floodplain and therefore its flood storage capacity. This has exacerbated the impacts of recent floods that have costs lives and resulted in serious economic and social impacts. It is therefore increasingly recognised that floodplain restoration in appropriate locations could reduce flooding impacts in future. Such measures could also provide other ecosystem service benefits, such as improved carbon sequestration in restored grasslands and improved water quality (e.g. as a result of reduced soil erosion and the filtering capacity of wetlands vegetation). Depending on the scale and location of floodplain restoration measures, some wetland recreation may be possible, which could result in biodiversity benefits and associated ecosystem services (e.g. carbon sequestration, fish production, hunting, reed production and tourism).

However, flood plain restoration measures need to be on a large scale to provide significant ecosystem service benefits, and such schemes are difficult to implement due to their costs and complexity. Therefore, although many initiatives are underway, and wetland conservation and restoration is recognised as a major priority within the Danube River Basin Management Plan it is uncertain what will be achieved in practice..

Climate regulation through carbon sequestration and storage

The DRB has important stores of carbon in its forests, and particularly old-growth forests, as well as its remaining extensive areas of semi-natural grassland. The economic value of these stores and ongoing sequestration varies considerably according to the ecosystem in question, its condition and the assumed value of carbon. However, a preliminary estimate suggests that carbon sequestration alone has a total notional value of €29m per year for the whole DRB (based on the carbon trading value of €12.97 per t C in the first half of 2010). However, this value is depressed by land use associated carbon losses.

Carbon losses in the DRB appear to be occurring as a result of the degradation of some carbon-rich habitats, such as old-growth forests, and ongoing losses of soil carbon as a result of intensive agricultural production and water erosion in significant areas. At the moment these losses are more than compensated for through afforestation in the region. However, carbon losses could increase if more old-growth forests are subject to logging and management and widespread conversion of grassland to arable farmland occurs. Further measures to protect and increase carbon stores in the region, including the stronger protection of forests and better management of soils therefore appear to be necessary. These in turn could provide co-benefits in terms of biodiversity, water quality and sustainable farming, as well as increasing ecosystem resilience with respect to climate change.

Nature-based tourism

Although national data on nature-based tourism are largely absent, several case studies in the region clearly demonstrate that such tourism is of substantial economic value in the DRB, with a preliminary estimate of at least €711 million per year across 10 DRB countries. Furthermore, the value of nature-based tourism appears to be rising with increasing importance being placed on nature and the environment by European tourists. Many national parks etc in the region are also being better protected, for example as a result of requirements under the EU's nature directives. However, although the exact relationship between nature-based tourism and environmental quality is not well understood it there is a significant risk that tourism, and its economic benefits, could decline significantly if habitats are not appropriately managed and associated rare and charismatic species are lost.

Overall conclusions

The evident importance of ecosystem services in the region supports the rationale for taking a precautionary approach to the conservation of ecosystem services. Unfortunately, ecosystem services are often weak drivers in decision making because their values are often unknown or underestimated, and rarely fully captured in economic markets. So a first step is to improve our knowledge of the relationships between ecosystem properties and the value of ecosystem services – in order to better inform decisions of policy makers as well as of businesses, markets and consumers.

In addition, more comprehensive and effective policies and regulations are needed to protect key ecosystem services, at least in the short-term, while measures to capture the values of ecosystem services in markets and other economic instruments are developed and implemented. The EU, national and international policy instruments that are in place across most of the Danube Basin, including e.g. the EU Water Framework Directive and Natura 2000 network of specially protected sites, provide a good framework for conserving biodiversity and some associated ecosystem services. But these require much better implementation and complementary measures aimed at the integrated protection and sustainable use of broader ecosystem services. Such measures could include:

- Developing integrated spatial plans for ecosystem services.
- Developing ecosystem service indicators and monitoring systems.
- Removing incentives for the unsustainable use of ecosystems and their services.
- Rewarding good practises via economic incentives, such as through sustainability criteria (e.g. to inform decisions on public procurement, public support and by private consumers).
- Investing in and restoring natural capital to find cost-effective solutions.
- Creating markets for some ecosystem services (e.g. carbon) and business partnerships.

Finally, all policy instruments must be better targeted and integrated to encourage multi-functional land use that supports a balanced range of ecosystem services rather than those driven by short-term and narrow economic needs. This will require a focus on governance and institutions and increased communication and integration across different sectors.

Recommendations

This study identified a number of further research and monitoring needs that would support the development and implementation of policy measures that aim to conserve and restore ecosystem services. In summary these recommendations are:

1. Carry out further scientific research to improve understanding of the interactions between ecosystem properties and the quantity and quality of key ecosystem service provision.

2. Further investigate the effects of changes in land use and land management practices on ecosystems and ecosystem services.

3. Carry out national assessments and more detailed local case studies that assess the monetary values of ecosystem services, and assess the potential impacts of ecosystem change on these values.

4. Develop and undertake studies that quantify the opportunity costs of maintaining ecosystem services and the cost of replacing lost or degraded services.

5. Increase understanding of the direct and indirect drivers of change affecting ecosystems and their services, and likely changes in demand and supply of ecosystem services, and therefore potential economic costs of ecosystem service delivery and loss.

6. Map existing and potential land uses and associated ecosystem services, and develop indicative tools that can inform the creation of strategic and holistic visions for multifunctional sustainable land use that support ecosystem services through the Ecosystems Approach.

7. Develop more comprehensive biodiversity indicators and complementary ecosystem service indicators, and develop systematic monitoring and reporting schemes for these.

VALUING AND CONSERVING ECOSYSTEM SERVICES: A SCOPING CASE STUDY IN THE DANUBE BASIN

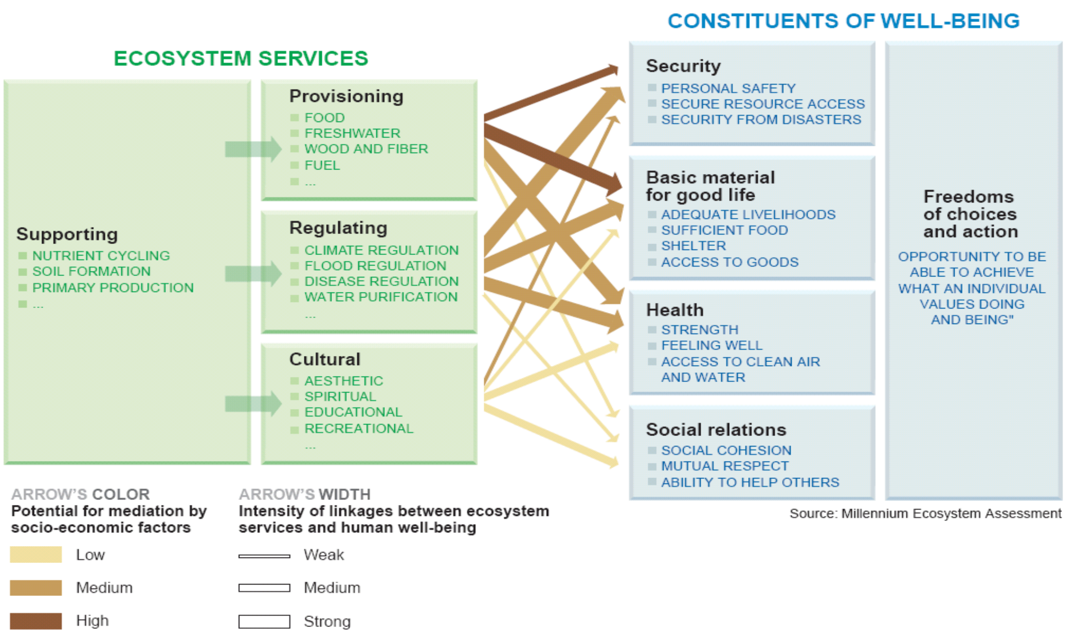
1 INTRODUCTION

1.1 Background

The concept of ecosystem services

As a result of studies such as the *Millennium Ecosystem Assessment* (MEA) (Millennium Ecosystem Assessment, 2005), it is increasingly recognised that ecosystems and biodiversity provide a wide range of benefits that are essential for human well being. According to the MEA, these ecosystem services include provisioning services such as food and water; regulating services such as regulation of floods, drought, land degradation, and disease; supporting services such as soil formation and nutrient cycling; and cultural services such as recreational, spiritual, religious, and other nonmaterial benefits (see Figure 1.1.1).

Figure 1.1.1. The Millennium Ecosystem Assessment Framework indicating the relationships between ecosystem services and constituents of well-being. Source: Millennium Ecosystem Assessment (2005).



Furthermore, the economic values of these ecosystem services are also being increasingly recognised as a result of recent initiatives such as the study on *The Economics of Ecosystems and Biodiversity* (TEEB, 2008, 2009) and its supporting studies (Balmford *et al,* 2008; Braat and ten Brink, 2008; Markandya *et al*, 2008). But at the same time, these studies are showing that the socio-and economic benefits that ecosystems provide are often overlooked, undervalued and poorly understood. Moreover, even when known, the values to society of ecosystem services tend not to be captured in markets and are therefore more often than not ignored in every-day decision making. The TEEB for Policy Makers study (TEEB, 2009) has therefore highlighted the importance of understanding the value of our ecosystems and to develop economic tools to capture and reward these values and encourage better sustainable use of our ecosystems (i.e. natural capital).

The European biodiversity and ecosystem service policy agenda

The importance of conserving biodiversity for both its intrinsic value and related ecosystem services has been widely recognised for some time in Europe. However, its significance was highlighted in the European Commission's adoption of a Communication on '*Halting Biodiversity Loss by 2010 – and Beyond: Sustaining ecosystem services for human well-being'* (CEC, 2006), and accompanying detailed European Union (EU) Biodiversity Action Plan (BAP). The BAP aimed to support the achievement of the EU's target of halting the decline of biodiversity by 2010 and of restoring habitats and natural systems (which was signed up to by EU Heads of State and Government in 2001). It also aims to contribute to the global target of the Convention on Biological Diversity (CBD) of reducing the rate of loss of biodiversity by 2010[1]. However, despite the production of the BAP and the implementation of existing biodiversity legislation and other measures, it is apparent that the EU has failed to achieve its target (CEC, 2010a). It is also obvious that the global CBD target will not be achieved (Butchart *et al*, 2010), which will inevitably also undermine the achievement of the United Nations Millennium Development Goals (Sachs *et al*, 2009).

Within the EU good progress has been made with the establishment of the Natura 2000 network of protected areas[2], but a large proportion of the habitats and species for which these sites were established have an unfavourable conservation status (CEC, 2009). Furthermore, other biodiversity indicators, such as bird and butterfly population trends, show that many species are continuing to decline in the wider environment (CEC, 2010b).

Biodiversity declines are continuing primarily as a result of ongoing and increasing pressures, in particular:

- Increasing intensification of agricultural systems in many areas, and abandonment of less productive agricultural land and traditional management practices (as a result of falling profits), both of which result in the loss of semi-natural grasslands and other High Nature Value habitats.

- Conversion or planting of forests with mono-cultures of non-native species, and intensive forest management.

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[1] The CBD target was to "to achieve by 2010 a significant reduction of the current rate of biodiversity loss at the global, regional and national level as a contribution to poverty alleviation and to the benefit of all life on Earth", and was subsequently endorsed by the World Summit on Sustainable Development and the United Nations General Assembly at the 2005 World Summit, and incorporated into the Millennium Development Goals – see http://www.cbd.int/2010-target/about.shtml

[2] Consisting of Special Protection Areas as designated under the Birds Directive and Special Areas of Conservation designated under the Habitats Directive.

- Increasing urban, industrial and related infrastructure developments, especially in favoured areas such as valleys and coasts.
- Eutrophication and acidification of many natural and semi-natural ecosystems (from water and air borne pollutants).
- Overexploitation of marine fish stocks, with associated by-catch impacts and damage to sensitive habitats from fishing gear.
- Increasing numbers and spread of invasive alien species, especially in marine and freshwater ecosystems.
- Unsustainable and illegal hunting of some species.
- Climate change, including direct ecological impacts and indirect impacts as a result of some mitigation and adaptation measures, such as inappropriate renewable energy projects and flood defence measures (Turner *et al*, 2010).

These pressures and resulting biodiversity impacts have persisted and grown despite the existence of a relatively comprehensive legal and policy framework for biodiversity conservation. Where environmental legislation has been well designed and enforced it has provided major biodiversity conservation benefits (e.g. most of the provisions in the Birds and Habitats Directives). But ineffective or slow implementation of existing measures has been widespread. This has often been the result of inadequate funding for practical biodiversity measures, such as the appropriate management of Natura 2000 sites (Kettunen *et al*, 2009) and the limited capacities of government environmental agencies and other conservation organisations to support and monitor actions, despite their best endeavours.

Such problems are exacerbated by perverse subsidies that often provide stronger economic incentives for activities that damage biodiversity rather than conserving it, e.g. the use of structural funds to support agricultural intensification or damaging infrastructure developments. Furthermore, land use and other policy decisions often overlook or underestimate the full socioeconomic value of biodiversity and do not internalise the costs of biodiversity loss (TEEB, 2008, 2009). This failure to incorporate the full costs and benefits of biodiversity in economic systems has been a key driver of biodiversity loss (and is reflected in the economic imbalance between urban and rural areas, as seen in all the Danube countries) and remains a constraint on the effective use of market measures to conserve it.

The past biodiversity conservation failings, increasing awareness of the value of ecosystem services and the need to mobilise deeper cross-sectoral support have stimulated the development of a more ecosystem service focused conservation agenda in recent years for biodiversity (Kettunen *et al*, 2009). This is reflected in the new EU biodiversity target[3] which is "*To halt the loss of biodiversity and the degradation of ecosystem services in the EU by 2020, restore them in so far as*

[3] Agreed at the European Council on 26th March 2010: http://www.consilium.europa.eu/uedocs/cms_Data/docs/pressdata/en/ec/113591.pdf

feasible, while stepping up the EU contribution to averting global biodiversity loss.” A new EU biodiversity strategy is currently being developed to identify and promote the actions required to meet the new target.

It is clear that a better understanding of the values of ecosystem services, together with the impacts of drivers, land use changes and other pressures on them is needed to support biodiversity conservation objectives and inform policy developments. For example, at the policy level there is an increasingly strong case for targeting a higher proportion of payments made under the Common Agricultural Policy (CAP) to measures that support important ecosystem services (public goods) that are undersupplied by current markets (Cooper *et al*, 2009). Moreover, within the Danube basin itself, there are several key policy objectives and initiatives that should clearly give a high priority to integrated conservation and restoration of ecosystem services including:

- Development of the Danube Strategy, the EU’s new approach to macroregional development in the Danube region that is inspired by the Baltic Strategy;
- Programming for EU regional and rural development funds for the next financial period, 2014-20;
- Implementation of the first cycle of the Danube River Basin Management Plan (ICPDR 2009) as well as preparation for the second cycle of the plan;
- Development and implementation of the Carpathian Convention, including the Biodiversity and Forestry Protocols;
- Ongoing initiatives to protect and restore key ecosystems, including Danube floodplains (e.g. implementation of the Lower Danube Green Corridor; Danube-Drava-Mura Biosphere Reserve), Carpathian Old Growth and High Conservation Value Forests as well as High Nature Value farmland.

1.2 Objectives

This report aims to support the conservation of biodiversity and associated ecosystem services, by providing a scoping assessment of how to put the key recommendations of the TEEB study into practice, through a case study of the Danube River Basin (DRB) as defined in Figure 1.2.1. It primarily demonstrates the potential benefits of an ecosystem-service based approach to land management, whilst also identifying potential constraints and opportunities.

Figure 1.2.1. The Danube River Basin

In particular this report reviews and summarises existing information in order to:

1. Identify key ecosystem services and their sources, flows and beneficiaries.

2. Quantify these key ecosystem services, where possible in terms of social and economic values.

3. Assess the status of existing key ecosystem services (i.e. in terms of their extent and condition) and identifies associated interactions with land uses and likely future threats.

4. Outline likely future trends in demand and supply of each key service according to projected socio-economic developments and land use changes that are based on current business-as-usual policies.

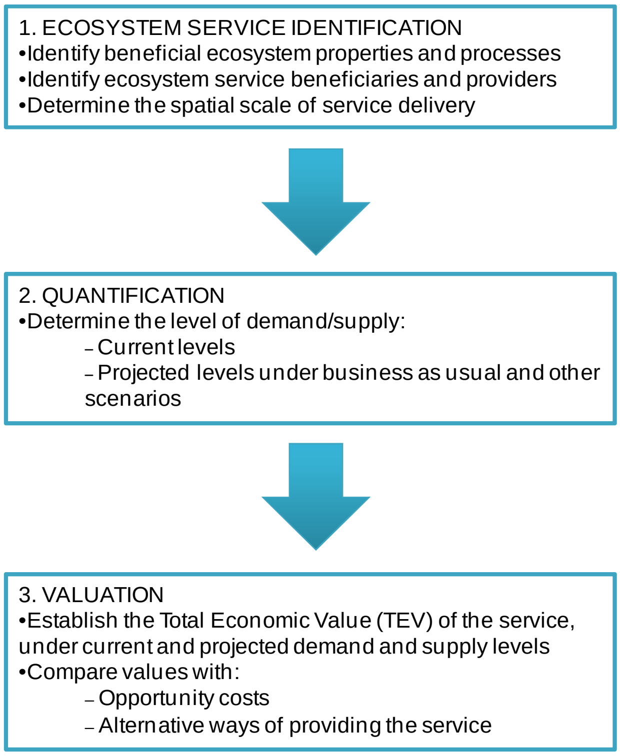
5. Identify existing and required key policy instruments and measures that can support the provision of ecosystem services in the region, in particular TEEB tools such as payments for ecosystem services, subsidy reforms, protected area designation and management and ecosystem restoration.

6. Examine the scope and detail of further information and analysis that would be required for an in-depth understanding of benefits, costs and policy needs.

A simple analytical framework is used for the identification, quantification and valuation of ecosystem services that draws on concepts developed under the

RUBICODE project,[4] as summarised in Figure 1.2.2. However, as a scoping study, it is important to note that this report is only based on an initial analysis of readily available information, and therefore only preliminary results are reported here. Hence a key objective of the report is the identification of further information and steps required to further implement the TEEB philosophy in the region.

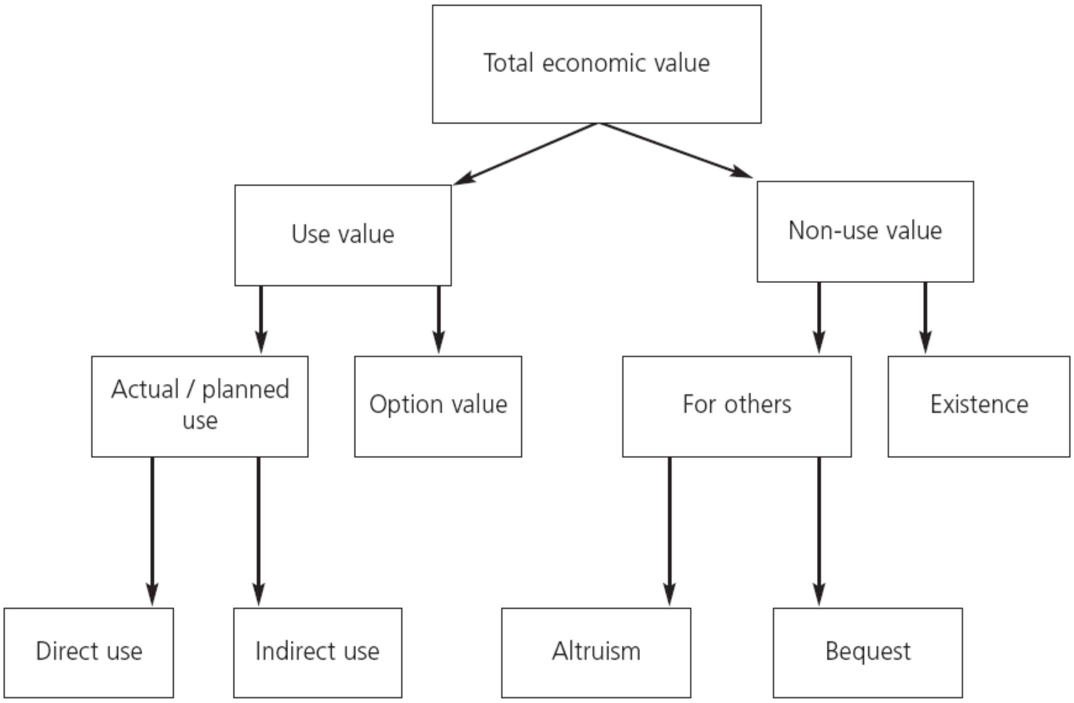
Figure 1.2.2. A framework for the identification, quantification and valuation of ecosystem services



A particular challenge associated with this study concerns the economic valuation of ecosystem services. This is a complex subject and a wide variety of valuation approaches have been developed, which reflect the types of ecosystem processes and functions that are involved, their benefits or types of benefit, or mixtures of these (see Pearce and Warford, 1993; OECD, 2001; Pearce *et al*., 2002; Spagiola *et al*., 2004; Defra, 2007: CBD, 2007; TEEB Foundations, 2010). Although a detailed evaluation of ecosystem services according to these methods is not within the scope of this study, their concepts have been taken into account. In particular the principal concepts in the Total Economic Value (TEV) framework (Pearce and Warford, 1993) have been followed in this study, where data allows, as these have been widely adopted. The TEV framework also usefully classifies ecosystems services and goods in terms of the way they are used, and refers to use values and non-use values (see Figure 1.2.3).

[4] Rationalising Biodiversity Conservation in Dynamic Ecosystems, carried out under the European Commission's Sixth Framework Programme: www.rubicode.net

Figure 1.2.3: The Total Economic Value Framework



(Source: DEFRA 2007, based on Pearce and Warford, 1993)

Use values

Direct use values refer to an ecosystem's goods and services that are used directly by human-beings, such as food and materials (i.e. *consumptive* uses) and natural areas for recreation (i.e. *non-consumptive* uses). Beneficiaries of direct use values include local communities (e.g. farmers), visitors and consumers.

Indirect use values refer to benefits such as the maintenance of healthy productive soils, natural hazard regulation (e.g. erosion control) and carbon sequestration. Beneficiaries of these services are not only visitors and locals, but also communities outside the ecosystem itself, and in the case of carbon sequestration, the global human population.

Option values are derived from retaining the potential to benefit from the ecosystem goods and services in the future, even if they are not currently used.

Non-use values

Bequest values refer to the value people attach to a certain ecosystem goods and services due to the fact that it will be passed on to future generations.

Altruistic values derive from the knowledge that a good or service will be maintained for the use of others in the current generation.

Existence values are those derived from the simple knowledge that environmental components, such as wild areas, and beautiful and mysterious species exist, even though they may not be personally experienced.

See also TEEB Foundations (2010).

2 THE DANUBE BASIN

2.1 Geography and ecology

According to the International Commission for the Protection of the Danube River (ICPDR)[5], the DRB is Europe's second largest river basin, with a total area of 801,463 km², and includes the territories of 19 countries (Table 2.1.1).

Table 2.1.1. The countries that make up the Danube River Basin (Source: ICPDR website[6] accessed 31/8/2010)

Where data are only available on a whole country basis (and not portions in the DRB), then the study focuses on those countries that are highlighted in bold below.

Country	Coverage in DRB (km²)	% of DRB	% DRB in country	Population in DRB (Mio.)
Albania	126	<0.1	0.01	<0.01
Austria*	80,423	10.0	96.1	7.7
Bosnia & Herzegovina*	36,636	4.6	74.9	2.9
Bulgaria*	47,413	5.9	43.0	3.5
Croatia*	34,965	4.4	62.5	3.1
Czech Republic*	21,688	2.9	27.5	2.8
Germany*	56,184	7.0	16.8	9.4
Hungary*	93,030	11.6	100.0	10.1
Italy	565	<0.1	0.2	0.02
Macedonia	109	<0.1	0.2	<0.01
Moldova*	12,834	1.6	35.6	1.1
Montenegro*,**	7,075	0.9		
Poland	430	<0.1	0.1	0.04
Romania*	232,193	29.0	97.4	21.7
Serbia*, **	81,560	10.2		
Slovak Republic*	47,084	5.9	96.0	5.2
Slovenia*	16,422	2.0	81.0	1.7
Switzerland	1,809	0.2	4.3	0.02
Ukraine*	30,520	3.8	5.4	2.7
Total	801,463	100.0		81.0

Notes: Data in the table above are based on the Danube Basin Analysis 2005.

* Contracting Party to the ICPDR

** Serbia and Montenegro split into two countries in June 2006. So no exact data on the share of the individual countries is currently available.

All Danube countries with territories >2,000 km^2 in the basin are Contracting Parties to the Danube River Protection Convention[7] (DRPC): i.e. Austria, Bosnia and Herzegovina, Bulgaria, Croatia, the Czech Republic, Germany, Hungary, Moldova, Montenegro, Romania, the Republic of Serbia, the Slovak Republic, Slovenia and Ukraine. This study therefore covers these countries, where data allows, and where feasible, limits assessments to those parts that fall within the DRB. Where data are only available on a country basis then this study focuses on Austria, Bulgaria, Hungary, Romania, Serbia and Slovakia as each constitute 10% or more of the DRB and more than 25% of their national area occurs within the DRB.

[5] http://www.icpdr.org/icpdr-pages/river_basin.htm
[6] http://www.icpdr.org/icpdr-pages/countries.htm
[7] Convention on Cooperation for the Protection and Sustainable Use of the Danube River (Sofia, 1994).

The Danube River Basin District (DRBD) is the area covered by the River Basin Management Plan developed in accordance with the requirements of the EU Water Framework Directive. It is larger than the DRB as it also includes the Black Sea coastal catchments of Romania and the Black Sea coastal waters along the Romanian and partly Ukrainian coasts.

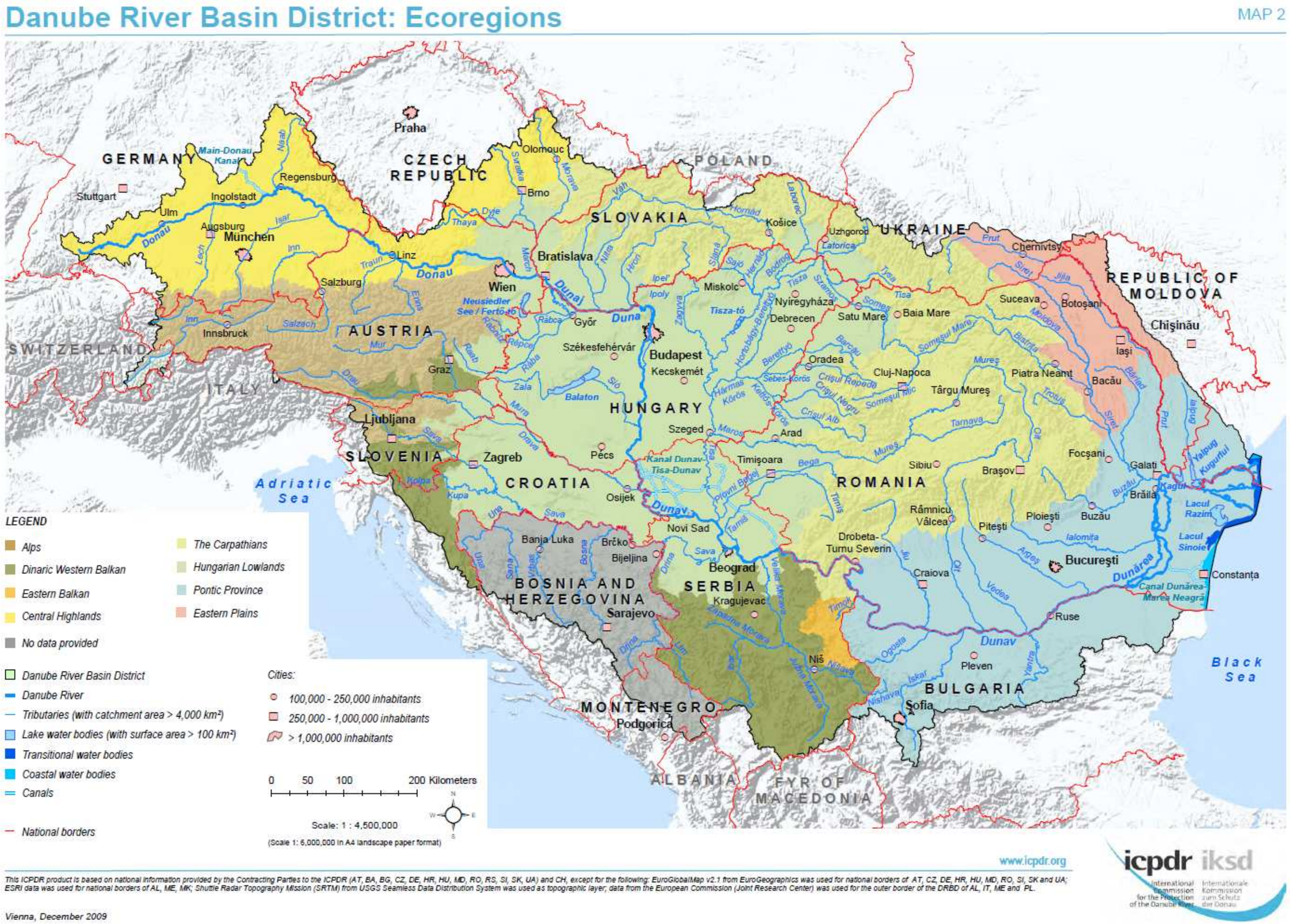
The Danube is 2,857 km long, and up to 1.5 km wide, with depths of 8 metres in places. On the basis of its gradients, it can be divided into three sub-regions. The Upper Basin extends from the source of the Danube in Germany to Bratislava in Slovakia. The Middle Basin is the largest of the three sub-regions, extending from Bratislava to the dams of the Iron Gate Gorge on the border between Serbia and Romania. The lowlands, plateaus and mountains of Romania and Bulgaria form the Lower Basin of the River Danube. Finally, the river divides into three main branches, forming the Danube Delta, which covers an area of about 6,750 km^2.

The DRB covers a very large area and range of altitudes (from the Austrian Alps to sea level) and incorporates four of the EU's nine biogeographical regions[8] and therefore holds a very wide variety of ecosystems, habitats and species. The ecoregions within the DRB are shown in Figure 2.1.1. These include the dry Pannonian plains of Hungary and Slovakia, which are home to 40% of Hungary's plant species, the low lying plains and wetlands of the Black Sea and steppic lower Danube, along with the continental forests and alpine habitats towards the edges of the River's watershed. The Hungarian Puszta plains and the great reedbeds of the Danube Delta in Romania are internationally renowned for harbouring some of Europe's rarest species, such as the Dalmatian and White Pelican (*Pelecanus crispus* and *P. onocrotalus*). Equally the Basin's beech and oak woodlands hold some of the largest areas of old growth forest in Europe, while the Carpathian Mountains are home to half the continent's populations of Brown Bear (*Ursus arctos*), Wolf (*Canis lupus*), and Lynx (*Lynx lynx*).

Consequently, the Upper Danube and the Dniester–Lower Danube have been included in WWF's global list of freshwater ecoregions, indicating that they are amongst the world's most valuable ecosystems from a biological perspective. The basin's importance is also recognised in the large number and area of designated Natura 2000 sites[9].

[8] http://ec.europa.eu/environment/nature/natura2000/sites_hab/biogeog_regions/index_en.htm
[9] Ie Within the EU, Special Protection Areas designated under the Birds Directive and Special Areas of Conservation as designated under the Habitats Directive.

Figure 2.1.1. Ecoregions and major rivers within the Danube River Basin District (Source: ICPDR 2009)



The Carpathian wilderness and the free flowing waters of the Lower Danube are not the only areas where biodiversity is abundant. Much of the agricultural land, in the DRB, especially in uplands, remains as traditional, low intensity farming. Of particular importance are High Nature Value (HNV) semi-natural grasslands (Beaufoy *et al*, 1994; EEA, 2004), which cover about 16% of utilised agricultural area in Romania[10] and 38% in Bulgaria[11], amounting to some 4.4m ha. Here the extensively-managed farming areas offer an example of how the region's rich biodiversity is maintained not only preserving areas of wilderness, but also through sustainable use and management.

2.2 Key drivers and trends

Recent trends

In line with global trends over the last few decades, much of the DRB has been influenced by economic growth, with small increases in per capita Gross Domestic Product from 1995 to 2007, although Austria's dropped by about 9% over the period.[12] Furthermore, most DRB countries are now Member States of the EU, and are therefore under particularly high pressure from capital market forces, some policy measures and funds under the Common Agricultural Policy (CAP) and Structural Funds that both encourage agricultural intensification and support development projects (such as those related to tourism, industry and transport infrastructure). Such economic growth is a major driver of land use change and so alters the region's ability to provide ecosystem services (IEEP and Alterra, 2010).

Another important driver of land use change and therefore likely ecosystem degradation is population growth. Such demographic changes (especially if combined with economic growth) lead to direct increases in demand for food products, housing, work facilities, transportation and recreation. Within the major DRB countries of Austria, Bulgaria, Hungary, Romania, Slovakia, and Slovenia (which account for over 60% of the DRB's area) the population change experienced over recent years is highly variable. Bulgaria and Romania, for example, suffered population decreases of approximately 42,000 and 36,000 people between 2008 and 2009 respectively (EUROSTAT, 2009), while Austria's population rose by about 20,000 people (Figure 2.2.1). However, when the net change of all these Danube countries is combined, and adjusted to take into account the area of each country in the DRB, the net change is a decrease of over 28,000 per year, which is largely due to the falling populations of Romania, Hungary, and Bulgaria. While this suggests the region's natural resources are not under increasing pressure from population growth, it also indicates that HNV farmland may be at risk from abandonment, especially as remote rural areas tend to be the first to experience depopulation (Anon., 2005).

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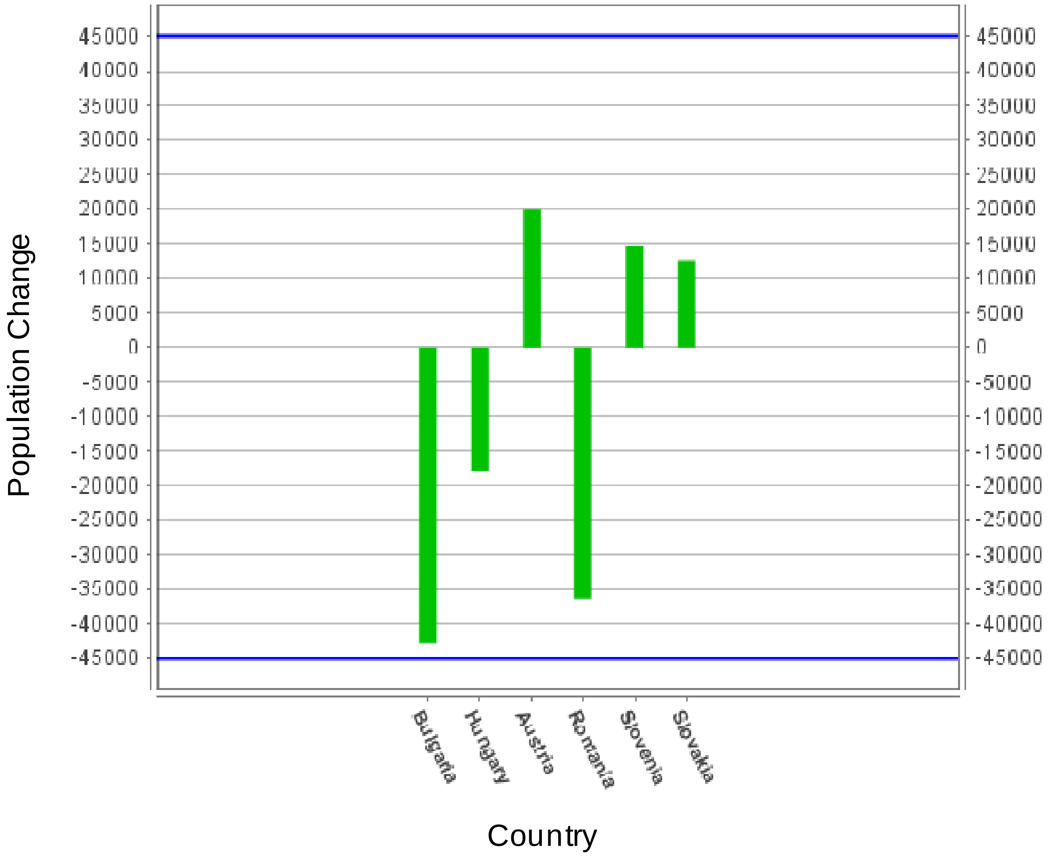
[10] Ministry of Agriculture of Romania data, 2007
[11] Ministry of Agriculture of Bulgaria data, 2007
[12] in terms of GDP per Capita Purchasing Power, Eurostat data: http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&plugin=1&language=en&pcode=tsieb010

Figure 2.2.1. Population changes in selected Danube River Basin countries from 2008-2009 **(Source: Eurostat 2010)**



Economic growth and globalisation, technical innovations and within the EU, supportive measures under the CAP, have also encouraged changes in land use, and in particular agricultural intensification. In common with most of Europe, the most significant land use trends in the DRB have been increases in forests,) and urban areas, and little change in the overall area of agricultural land, but declines in grasslands (Hazeu *et al*, 2008; Feranec *et al*, 2009; IEEP and Alterra, 2010). Forest expansion in the region has occurred as a result of afforestation programmes and regeneration following agricultural abandonment. However, the situation varies amongst the countries, and according to spatial studies of land use changes between 1990 and 2000 by Feranec *et al* (2009), the countries with the most significant increases in forest within the DRB have been the Czech Republic, Hungary, and Slovakia. Moreover, it is important to note that whilst total forest area has increased there have been significant losses of biodiversity rich old-growth forests, and newly afforested land is of much lower ecological value. Agricultural intensification has generally been much higher in Western Europe, with only Hungary and Slovakia having large areas affected between 1990-2000. However, it is likely that intensification trends have spread and quickened more recently.

As described further in Chapter 3, these socio-economic drivers and associated changes in land use have resulted in growing pressures and impacts on ecosystems and their ecosystem services in the DRB. However, it should be also noted that some of the potential impacts of these land use changes may have been mitigated to some extent by growing environmental awareness and concern over environmental degradation. For example, concern in the EU over the intensification of agricultural production, led to the introduction of agri-environment measures in 1985, followed by the successive integration of environmental objectives into the CAP (Tucker *et al*, 2010).

Future trends

According to a recent study by IEEP and Alterra (2010), the key drivers of land use change in the EU (many of which will directly or indirectly affect other DRB countries) over the next 25 years to 2030 are likely to primarily be:

- A growing global population and economy (despite the recent downturn), leading to an increase in the demand for food, energy and materials for housing, built infrastructure and consumer products.
- Concerns over food security and the availability of food, leading to some increases in production and yields, facilitated by technological advances and high commodity prices.
- Changing consumption patterns, including an increase in the share of meat and dairy products in diets, especially in developing nations such as India and China.
- An increase in the demand for bioenergy feedstocks, which will be mostly met by production outside the EU.
- Full decoupling of direct payments for farmers, transfer of funding from Pillar 1 to Pillar 2, and the reorientation of CAP support towards the provision of environmental public goods and ecosystem services.
- EU Energy policy and a new post Kyoto climate policy, stimulating action on the sequestration and carbon in soils and biomass, forestry measures, adaptation and mitigation.
- Further rural depopulation, especially in remote areas with marginal agricultural systems.
- International commitments on biodiversity and the implementation of the MEA Framework.
- Implementation of the Water Framework Directive and the introduction of a Soil Thematic Strategy.
- Increasing impacts of climate change on ecosystems and land uses, resulting in, for example, shifts in production of drought sensitive crops from southern Europe to central European regions such as the DRB where water resources are more plentiful for irrigation.

These factors may therefore lead to significant changes in the balance of land uses, especially between agriculture, forestry and the built environment. In the absence of major changes in policy, it is likely that agricultural drivers will lead to either intensification in production on the more competitive farms, or further undermine the economic viability of more marginal farms, leading to further abandonment across the EU (Farmer *et al*, 2008). In fact spatially-specific land use modelling carried out as part of a study of land use change in the EU up to 2030, suggest that according to the models and scenarios used[13], all main DRB countries will experience major reductions in grasslands and semi-natural habitats (except Austria) and significant increases in forest cover (Table 2.2.1). Agricultural intensification is also likely to occur over much of Eastern Europe as many systems are less intensive than those in Western Europe, which gives more scope for profitable agricultural investments. However, the large areas of HNV farmland in the region are more likely to be at risk of abandonment than intensification, although this is possible in some areas following restructuring of holdings.

Clearly these changes may have significant impacts on ecosystem services, and therefore the potential implications of these are taken into account in the detailed analysis of selected services in the next chapter.

Table 2.2.1. Modelled projected changes in CORINE land cover types (km^2) according to the B1 Global Cooperation scenario for selected Danube River Basin countries between 2000 and 2030 (Source: adapted from IEEP and Alterra, 2010).

	Percentage Change in Arable (km^2)	Percentage Change in Grassland (km^2)	Percentage Change in Forest (km^2)	Percentage Change in Semi-natural areas (km^2)
Austria	-31%	-15%	1%	18%
Bulgaria	-7%	-14%	22%	-39%
Hungary	0%	-18%	1%	-17%
Romania	-6%	-12%	9%	-17%
Slovakia	3%	-18%	7%	-66%
Slovenia	0%	-9%	7%	-55%

3 KEY ECOSYSTEM SERVICES IN THE DANUBE RIVER BASIN

3.1 Introduction

The River Danube and its associated ecosystems play an important role in supporting the livelihoods of the Basin’s 83 million inhabitants. A range of ecosystem services are provided, including biodiversity conservation, water purification, flood prevention, healthy fisheries, and tourism. Furthermore a number of studies have shown that these can provide substantial social and economic benefits.

For example, a study for the publication *10 years of restoration in the Danube Delta* (WWF, DDBRA and DDNI, 2004) assessed the value of a restored floodplain in terms of its economic goods (fish, reeds, pasture/cattle) and other ecological services (water storage, nutrient removal, sediment retention, habitat for birds and fishes, aesthetic value). The annual benefits in terms of fish, reeds, cattle and tourism, were estimated to have an overall value of about €40 per ha. Estimates of the nutrient reduction (nitrogen, phosphorus) provided by floodplains differed widely depending

[13] This incorporated the use of the IPCC Scenario B1 and three models operating at different spatial scales: GTAP (Global Trade Analysis Project), IMAGE (Integrated Model to Assess the Global Environment), and CLUE (Conversion of Land Use and its Effects).

on data from the literature, ranging from €250 to €800 per ha per year (see also Barbier *et al*, 1997). A similar calculation of the economic value of restoration of the lower Danube, estimated the annual benefits based on Romanian expert estimations for nutrient reduction, provision of fish, reed, crops, vegetables, animals and tourism, to be €1,354 per ha (Kettunen and ten Brink, 2006). The difference with the previous study is mostly due to the influence of nutrient reduction (which in the latter study amounted to €870 per ha per year).

Another WWF study of the Danube floodplain estimated that the annual value of fish production, forestry, animal forage and nutrient retention as well as recreation amounted to about €380 per ha (WWF, 1995). On the basis of these highly differing economic values, an average annual value was calculated by Schwarz, *et al* (2006) to be around €500 per ha. This compares favourably with the average annual income from agricultural land in Eastern Europe, which has been estimated at about €450 per ha (excluding agricultural subsidies), based on data from Lithuania (Segrè and Petrics, 2005).

Mountain and forest areas are also important areas for tourism and provide a range of other important services, including timber, watershed protection, carbon sequestration and hunting grounds etc. Information on these in the DRB is less readily available, but a detailed case study of all ecosystem services in the Maramures Mountains Natural Park in Romania was conducted by Ceroni (2007). The results of this are summarised in Table 3.1.1 below (with further details provided on water provisioning in Box 3.3.1).

Once arable land and other uses (roads, development and infrastructure) are subtracted from the surface area of the National Park, the annual value of ecosystem goods and services provided by the park is about 1,100 RON per ha (approximately €259 per ha) when carbon is valued at its lowest value. But if the value of carbon sequestration in the National Park is higher than its exchange value and reflects the societal costs of extra CO^2 emissions, the total per ha value of goods and services in the National Park is 2,175 RON (about €511), roughly twice as much than when lower, more conservative estimates are included. Thus the total annual value of ecosystem services provided by the park can be estimate to vary between 149m RON (about €35m) and 294m RON (about €69m) depending on the adopted carbon value.

Table 3.1.1. Total annual values of ecosystem services and ecosystem goods in Maramures Mountains Natural Park, Romania (Source: based on Ceroni, 2007).

Ecosystem service	Total value (RON)	Total value (Euro)
CO_2 sequestration		
- with low carbon value	26,470,357	6,224,557
- with high carbon value	171,722,253	40,380,831
Watershed protection	43,294,683	10,180,831
Erosion control	-3,189,102	-749,924
Wildlife habitat	799,867	188,090
Recreational fishing (consumer surplus only)	684,677	161,003
Recreation	4,835,000	1,136,960
Cultural heritage	736,994	173,306
Traditional landscapes	588,877	138,476
Total for ecosystem services		
- *with low carbon value*	*77,410,457*	*18,203,224*
- *with high carbon value*	*222,662,353*	*52,359,498*
Ecosystem goods	**Total value (RON)**	**Total value (Euro)**
Water supply	1,848,000	434,561
Hay	34,685,471	8,156,358
Timber	31,876,000	7,495,705
Non-timber forest products	3,644,674	857,052
Hunting	102,075	24,003
Total for ecosystem goods	72,156,220	16,967,679
TOTAL		
- **with low carbon value**	**149,566,677**	**35,170,903**
- **with high carbon value**	**294,818,573**	**69,327,177**

Taking these studies and other studies into account and the opinion of WWF experts in the region the overall importance of each of the main types of ecosystem service have been ranked in semi-quantitative terms (Table 3.1.2). This information together with an assessment of the availability of sufficient data to evaluate each service was then used to select a number of key ecosystem services that are the focus of detailed assessments in the remaining sections of this chapter.

Table 3.1.2. Overview of socio-economic importance of provisioning, regulating and cultural the ecosystem services in the EU and Danube River Basin, and assessment of availability of valuation data

EU assessment of importance taken from EASAC (2009).

Key: H = High; M = Medium; L = Low. Ecosystems: agriculture, i.e. arable and permanent crops and temporary intensive grasslands; natural and semi-natural permanent grasslands and shrublands; rivers, lakes and other wetlands; forests. Services in bold type are analysed in detail in Sections 3.2 – 3.6.

ECOSYSTEM SERVICE	EU	DRB	ECOSYSTEMS				Data
			Agri	Grass	Riv / wet	For	
PROVISIONING							
Food crops / livestock	H	H	H	H		L	M
Fisheries		L-M			L-M		M
Water quantity (see also Regulation)	H	H		M-H	H	H	M-H
Fuel	M	M	M	M	M	M	L-M
Fibre	M	M	M				L
Biochemicals	L	L	L				L
Genetic resources	L	H		M-H	H	H	M-H
Environmental quality*1	H	H		M	H	H	L
REGULATION							
Climate regulation through carbon sequestration and storage	LH	H		M	H	H	L
Pest / disease regulation	?	?	?	?	?	?	L
Water quality (see also Provisioning)	H	H		M	H	H	M-H
Pollination	M	M	L	M	M	L	L
Flood mitigation and other natural hazard regulation*2	-	L-M*3	M	M	M	M	M-H
Soil erosion regulation*2	-	M		M-H		L	L-M
CULTURAL							
Spiritual / religious / aesthetic / inspirational / sense of place	H?	H		H	H	H	M
Recreation / ecotourism / cultural heritage	H	H		M	H	H	M
Education and research		H		H	H	H	M-H

Note. *1. Provision of clean air and safe and peaceful environment. *2. Not covered in EASAC study. *3 Current flood mitigation functioning is low due to modification of the floodplain, but its potential value is high. Other natural hazard benefits, such as flood attenuation by upland ecosystems and landslide / avalanche protection by forests vary greatly according to circumstances.

3.2 River fish production

Description

The production of fish, for both commercial and subsistence use - is one of the most important ecosystem services in the Danube Basin. The Danube River is home to more than 100 species of fish, several of which are commercially valuable (ICPDR 2010[14]). In general, fisheries in the Danube River focus on native species including several species of sturgeon (e.g. *Huso huso, Acipenser stellatus, Acipenser guldenstaedtii*), Danube Shad (*Alosa pontica*), Common Carp (*Cyprinus carpio*) and Catfish (*Silurus glanis*). In addition, in the Danube Delta target fish species include Crucian Carp (*Carassius auratus gibelio*), Bream (*Abramis brama*), Pike (*Esox lucius*) and Pikeperch (*Stizostedion lucioperca*).

The fish species in the Danube Basin are migratory, i.e. they use the river and its floodplains to migrate between the various habitats that are used over their lifecycle. Depending on the species this migration can take place along the river (e.g. between the upper basin and the delta area) or on a more limited scale between the river body and the surrounding wetlands and floodplains. For example, a number of commercially valuable species in the Danube, such as the highly valuable sturgeon species, require specific conditions and areas for spawning.

Despite significant declines (see below), freshwater fisheries in the Danube Delta are of particular importance and still provide a major form of income to local populations, providing full- or part-time employment for sole or additional income.

Flow of service within the Danube Basin

Within the Danube Basin, capture fisheries are perhaps most important as a source of livelihood in the lower Danube and the Danube Delta area. However, the fish catch in these areas for species with long- and medium-distance migratory routes, such as sturgeons, depends heavily on the passage to and quality of habitats in certain parts of the Danube and its tributaries. These migration routes have been severely disrupted by the extensive hydrological constructions in the river. For example, the Upper Danube Basin (i.e. ca 1000 km of the river) has been divided by around 60 dams which makes migration to the upper parts of the river impossible (Figure 3.2.2 below).

On the other hand, the maintenance of sustainable fisheries for species with short migration routes (i.e. species migrating between the main body of the river and its floodplains and wetlands) is more dependent on the availability and quality of suitable habitats at local level.

[14] http://www.icpdr.org/icpdr-pages/plants_and_animals.htm

The key value-added products of fisheries in the Danube Basin (e.g. caviar) are mainly targeted to global markets, i.e. benefiting the global consumers and businesses. In addition, a large proportion of fish exports from the Danube Delta areas are targeted towards markets in the neighbouring countries. Finally, a certain proportion of fish catch is also used for subsistence purposes and / or traded in more local markets.

Consequently, the chain of stakeholders benefiting from and maintaining sustainable fisheries range from local to transnational and global levels, depending on the type of fishery and fishery products (Table 3.2.1). Understanding these different "flows" of fisheries service is important as it forms a basis for the further consideration of possible policy tools (e.g. TEEB approaches and instruments) that could be used to support more sustainable fisheries in the area (Chapter 4 below).

Status and trends

Over the past few decades, fish stocks in the Danube Basin have been in decline, primarily as a result of human actions (Box 3.2.1). Hydromorphological alterations of the river (e.g. the building of dams, dikes and hydropower stations, and the conversion of floodplains and wetland for agriculture), organic / nutrient / hazardous substances pollution from catchment areas and over-exploitation of certain fish stocks (e.g. sturgeon and Danube salmon) have been identified as the main causes for this decline.

Table 3.2.1. Overview of the "flow" of service in the Danube Basin - fisheries

Flow of the service			Stakeholders	
Where is the service produced ?	**Where is the service "enjoyed" ?**	**Scale**	**Who provides / helps to maintain the service ?**	**Who benefits ?**
For fisheries of long & medium distance migratory species (e.g. sturgeon): upper Danube Basin (e.g. Germany, Austria, Slovakia)	Lower Danube Basin & the Delta area (e.g. Romania, Bulgaria)	Transnational (i.e. from upper to lower basin)	Stakeholders along the upper Danube Basin *1	Local fishermen in the Danube Delta Regional / national / international producers of fisheries products (e.g. caviar)
For fisheries of local migratory species: local floodplains and wetlands around main river body	Locally / regionally along the Danube River. However, mainly in the lower Danube Basin and the Delta area	Regional / local	Stakeholders along the lower Danube Basin and the Delta area *1	Local fishermen in the Danube Delta Regional / national / international producers of fisheries products
Fisheries products - caviar: Lower Danube Basin , the Danube Delta and the Black Sea (e.g. Romania & Bulgaria)	At global level	Global	See above	Global consumers and businesses (e.g. restaurants)
Fisheries products – other: mainly lower Danube Basin, the Danube Delta	From local to national & transnational level, depending on the scale of trade	Local / regional / national / transnational	See above	Consumers and busineses using fisheries products at local / regional / national / transnational level

Notes: *1. The scale of stakeholders varies: national / regional level policies are responsible for destruction of floodplains and wetlands in the area whereas local land use practises at farm / municipal levels contribute to the general quality of fish spawning habitats.

Box 3.2.1. Evidence of recent declines in fish stocks in the Danube Basin

- In the Inn River in Germany over 30 fish species were originally present. After the construction of the first impoundment at Jettenbach in 1921, professional fisheries on the river collapsed. Today, only two fish species are able to maintain their stocks by natural reproduction in this part of the river (Danube Basin Analysis 2004).
- In the Austrian part of River Drau/Drava, a reduction of 50 per cent of the fish stock has been attributed to peak operation in the Möll tributary and the impoundment of the Malta tributary (Danube Basin Analysis 2004).
- The construction of flood control measures is estimated to have resulted in the loss of fish catches in the Rajka and Budapest section of the Danube during the last two decades, causing a decrease from over 300 tons in 1976 to approximately 50 tons in 1996 (Danube Basin Analysis 2004).
- In the lower Danube, the number of fish species has declined from 28 species prior to 1980 to 19 species today. Dominant species like the carp have been replaced by species of value for fisheries and have resulted in a decrease of overall fish catch from 6 000 ton / year down to 2 500 ton / year presently (Danube Basin Analysis 2004).
- In the Serbian part of the Danube river sturgeon have declined severely as a result of over-fishing, habitat fragmentation and pollution, and as a result some species are considered to be extinct or near extinct (Lenhardt *et al*, 2006).

The DRB has been heavily altered by different hydrological constructions (Figure 3.2.1 and 3.2.2 below). Altogether over 1,600 dams, weirs and ramps are located in the Danube River, its tributaries and some 300 water bodies in the basin (i.e. 44 per cent of the total number of water bodies) which significantly alter the continuity of the river (ICPDR 2009). The majority of these constructions still lack any functional aids for migratory fish, thereby preventing them from reaching crucial areas for reproduction. For example, important species such as Starry Sturgeon (*Acipenser stellatus*) and Sterlet (*Acipenser ruthenus*) can no longer reach their spawning grounds, feeding and shelter areas. Furthermore, the flood prevention dikes result in the loss of adjoining floodplain wetlands which are required for the completion of fish population lifecycles. Finally, polluted water and sediments has cause further degradation of fish habitats and also led to a lethal build-up of toxins within fish (e.g. sturgeons).

Figure 3.2.1. Overall hydromorphological assessment of the Danube River as longitudinal colour-ribbon visualisation, ranging from no-modified areas (Class 1) to heavily modified areas (Class 5). **Source: (ICPDR 2009).**

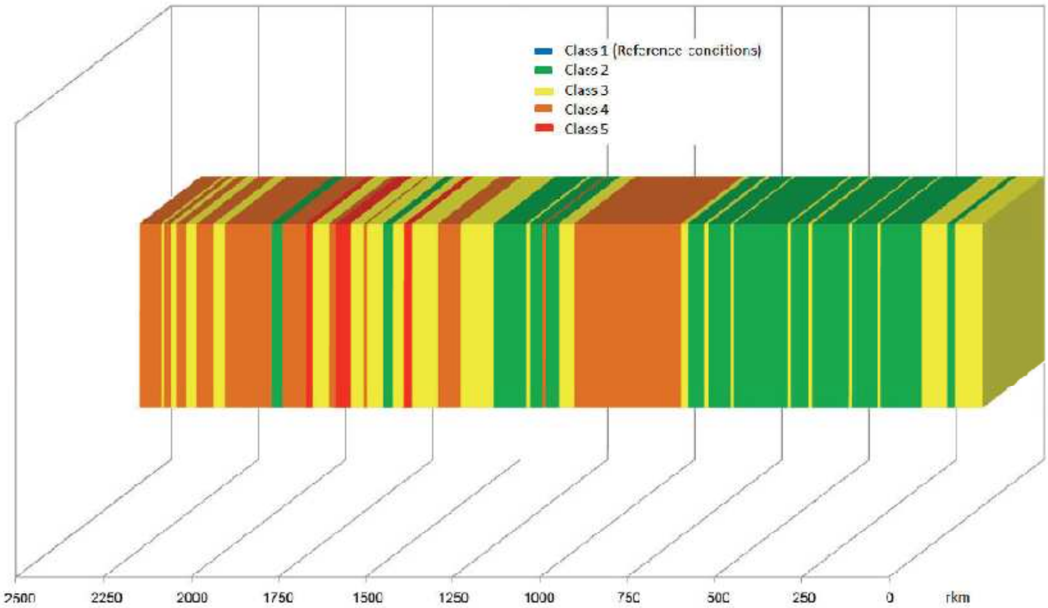
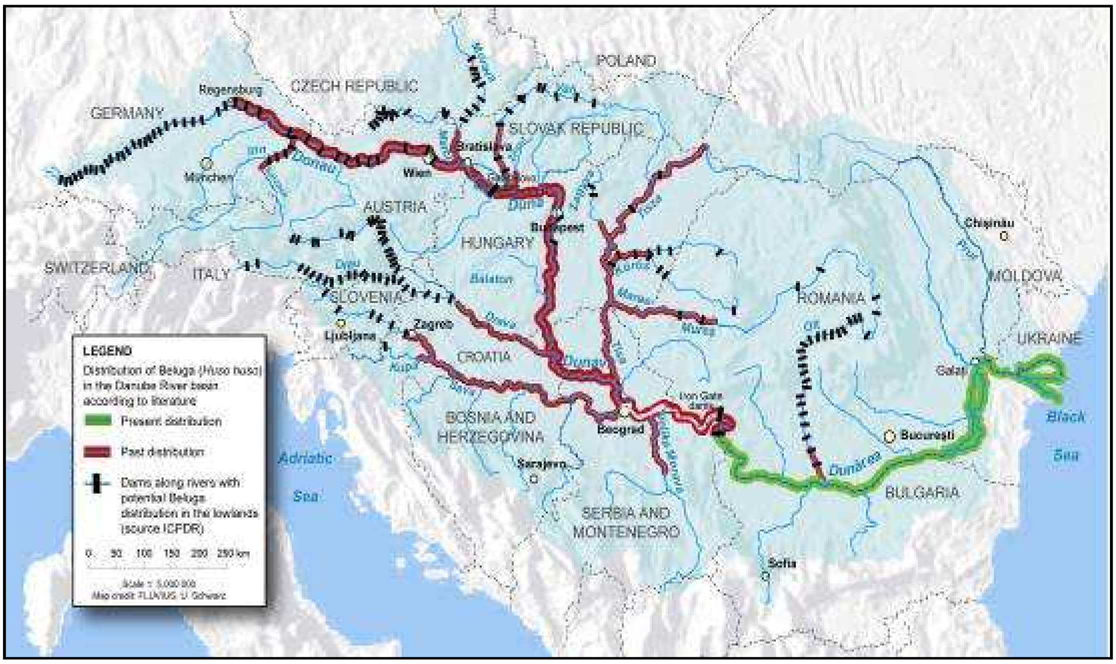


Figure 3.2.2. Overview of dams affecting the migration of Beluga sturgeon along the tributaries of the Danube River (Note: includes dams relevant for Beluga sturgeon only, not an exhaustive illustration of all dams in the Danube Basin). **Source: (FLUVIUS, U. Schwarz).**



Over-fishing has been generally considered as one of the key reasons affecting fish catches in the Danube Delta (ICPDR, 2009). In particular, it has been shown that migratory sturgeons have suffered from overfishing in the Danube River - documented by a decline of stocks in the upper and middle Danube even before the construction of the area's major dams. Furthermore, the use of inappropriate fishing gear (i.e. fishnets) in the Danube delta has been known to have a negative impact, preventing species from proceeding further up the Danube to reach their natural spawning areas. On the other hand, a number of common species, such as carp, are thought to be in decline due to the restocking of species with higher commercial value.

Due to the drastic decline in fish stocks (Box 3.2.1) fisheries do not provide a major contribution to the economy or source of livelihood in the Danube Basin at the moment. Nor are wild fisheries currently sustainable. For example, reproduction of some sturgeon species is now highly dependent on breeding in hatcheries. Currently around 90 per cent of recruitment to the Beluga (*Huso huso*) population depends on artificial breeding (International Association for Danube Research *et al*, 2006).

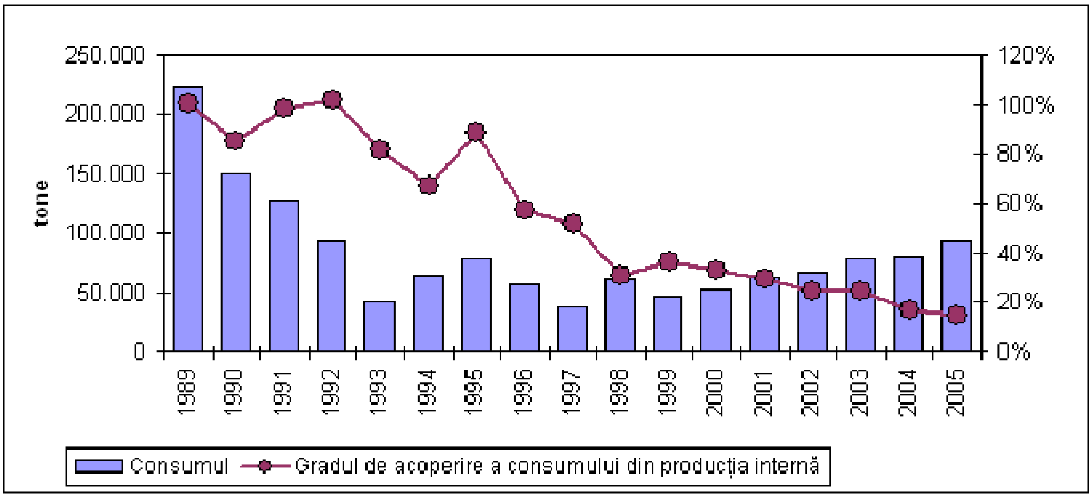
However, the demand for fish of high commercial value (i.e. sturgeon), remains high and could therefore be a potential source of revenue for a wider group of stakeholders within the Basin, especially in the lower Danube Basin and the Delta area. Therefore, although a significant recovery (e.g. through restocking and highly restricted fishing) could take many decades (Jaric *et al*, 2010), appropriate management of fisheries could in the long-term provide sustainable sources of livelihood for significant numbers of people in the Danube Basin, whilst also supporting the conservation and restoration of the water bodies, wetlands and floodplains.

Social and economic values

There is no synthesised information on the overall significance of fisheries – past and present – across the Danube Basin. Also, no basin-wide assessment is available documenting the decline in fish catch in the Danube, e.g. the associated loss of revenue. However, data from Romania indicates that fish consumption is increasing, and therefore if appropriately restored and managed, river fisheries could play a more prominent role as a source of livelihood in the future (Figure 3.2.2 below).

No information could be readily found during the course of this study on the monetary value of fisheries originating from the Danube area. However, it is well known that trade in caviar can be a significant source of revenue. It has been estimated that the retail value of caviar ranges from €300 per kg in unofficial local markets to around €1,000 – €6,000 per kg in duty free and luxury sales outlets (International Association for Danube Research *et al*, WWF 2006). Currently these prices result in high pressures on the already depleted sturgeon stocks in the Danube. However, they also show the potential for monetary benefits to be gained by the successful restoration and sustainable management of Danube's sturgeon populations.

Figure 3.2.2. Trends in the fish consumption (blue) and the total production (availability) in Romania. **Source: FAO FishStat (1989-2004) / PNS (2005)**



Conclusions

In general, it seems that the value and socio-economic importance of fisheries has diminished considerably as a result of human activities, including overfishing, pollution and changes to river habitats (Table 3.2.2). However, fisheries do still form a significant source of income for local communities in some areas, i.e. in the Danube Delta.

Given the importance of fisheries in the past and increasing demand for fish (e.g. sturgeon / caviar) it can be foreseen that the restoration of fisheries (e.g. ongoing restocking activities, increasing removal of barriers for migration and further conservation and restoration floodplains and wetlands) and effective regulation of over-fishing could in the long-term help to increase the value of fisheries in the future. This is especially true in the lower Danube and the Delta area.

Several examples are available documenting the decline in fish catches in the Danube Basin over recent decades. However, broader aggregated assessments of the overall economic losses due to the declines in fish stocks are hindered by the limited amount of basin-wide data that are currently available. Chapter 4 below provides more detailed information on data needs and possibilities for further assessments.

Table 3.2.2. Estimation of the overall status of fisheries in the Danube Basin.

CURRENT IMPORTANCE of the ecosystem service	QUALITY / AVAILABILITY of the ecosystem service		REASONS BEHIND CURRENT STATUS & TRENDS
	RECENT TREND	EXPECTED TREND (business as usual)	
Key commercially valuable fish species (e.g. sturgeons & Danube salmon): moderate	↓	↓	Hydromorphological works → barrier for migration and loss of habitats Over fishing Pollution
Fisheries of other species, mainly used for subsistence and local markets: low	↘	↔	Hydromorphological works → barrier for local migration and loss of habitats Pollution Favouring few species of value for fisheries

3.3 Water provisioning and purification

Description

Ecosystems play a major role in both the supply of water for human uses (such as domestic uses, agriculture and industry) and ensuring it is of a sufficient quality for its intended use. Although some classifications (such as in the MEA) consider that water availability and purification are distinct provisioning and regulation services respectively, they are closely interrelated and are therefore treated together in this account.

Water reaches freshwater stores (lakes, rivers and underground aquifers), from which it may be abstracted for human use, by a variety of routes, including direct precipitation, surface and subsurface flows. Therefore, ecosystem characteristics such as soil state, micro-climate and vegetation and their interrelations can have a significant influence on the fate of water and its speed of movement. Vegetation tends to trap and slow down the movement of water, thereby reducing direct surface runoff into rivers and lakes and increasing movement into the soil. Some of the soil water may then be taken up by plants and transpired or stored thereby reducing its movement into water bodies and availability for human use. However, some will move into water bodies, and this slow release can be beneficial in term of reducing peak flows (thereby attenuating floods) and maintaining flows during dry periods of the year (which may support freshwater ecosystems and associated species). The reduced surface runoff also tends to increase groundwater recharge rates, which provides an important benefit for those dependent on groundwater resources. Groundwater recharge may also be enhanced by the presence of wetland ecosystems, which slow water movements allowing greater infiltration into aquifers.

The presence of vegetation also has an important benefit in terms of water quality, as it reduces erosion rates, thereby reducing silty-runoff onto water courses. Such silt-rich runoff is often highly nutrient rich, especially in terms of phosphate, which is normally the limiting nutrient in freshwater ecosystems. Phosphates from fertilizer applications and livestock manure readily bind to soil particles and are therefore relatively immobile (in contrast to nitrates). Thus soil erosion can trigger eutrophication of water courses which can have significant impacts on several ecosystem services including the use of water for human consumption, fisheries and recreation.

The passage of water through soils has a particularly important impact on its quality, through transformations of persistent organic pollutants, sequestration and conversion of inorganic ions (nitrate, phosphate, metals), and removal of disease-causing microbes (EASAC, 2009). Wetlands can play a similar function in terms of filtering and improving water quality, this being the process that is replicated and enhanced in sewage works.

However, although soils and vegetation are known to be major determinants of water flows and quality, and microorganisms play an important role in the quality of groundwater, the relationship between water regulation and purification and biodiversity is poorly understood. Nevertheless, it is clear that changes in land use and land use practices that reduce vegetation cover, increase nutrient loads, increase soil erosion risks and reduce the overall ecological condition of soils are likely to reduce the availability of clean water (see below).

Flow of service within the Danube Basin

All inhabitants of the Danube basin rely to some extent on the availability of sufficient water of acceptable quality. Thus, the water provisioning and regulating services provided by forests, grasslands and soils etc benefit all inhabitants in the Danube catchment to some extent. The aggregated annual water consumption of the DRB population connected to centralised water supply systems is of the order of 30,849 million m^3 (ICPDR 2009). Others outside the basin might also benefit from inter-catchment transfers and there is likely to be a relatively small market in the supply of bottled mineral water which will probably extend outside the region.

According to the Danube Basin River District Management Plan (ICPDR 2009) the key water uses in the district that cause significant alterations through water abstractions are mainly for hydropower generation (76%), public water supply (5%), agriculture and forestry (3%) and irrigation (9%). Water abstractions for energy production (cooling water), manufacturing industry, navigation and other major abstracts totals 5%, with the remaining 2% unspecified.

In some cases, the water used for these purposes will be directly abstracted from lakes and rivers; the Danube being a drinking water source in many locations. However, groundwater aquifers are important sources of drinking water in Danube countries, supplying about 60% of the population in the basin. A 2004 analysis and review of groundwater bodies in the basin[15] identified 11 transboundary groundwater bodies or groups of groundwater bodies of basin-wide importance.

Table 3.3.1. Overview of the "flow" of service in the Danube River Basin - water availability and quality

FLOW OF THE SERVICE			STAKEHOLDERS	
Where is the service produced?	**Where is the service "enjoyed"?**	**Scale**	**Who provides / helps to maintain the service?**	**Who benefits?**
Vegetated areas with unsealed soils, low nutrient status and healthy ecosystems	Throughout the catchment, and to a lesser extent beyond	Catchment	Land managers (esp foresters, farmers)	All inhabitants (for domestic uses), agriculture and industry

Status and trends

Human actions have important direct impacts on water availability and quality, as well as indirect impacts through the effects of changes in land use and practices on ecosystems' ability to store and purify water. Firstly, water abstractions can reduce the flow and quantity of water and affect the ecological status of rivers where the minimum required flows of rivers are not maintained. Indeed, according to the Danube River Basin District Management Plan (ICPDR, 2009), 140 water abstractions are causing alterations in water flow in DRBD rivers covering over 4,000 km^2 and affecting 77 water bodies. But the River Danube itself is only impacted by alterations through water abstraction at Gabcikovo hydropower dam (bypass channel) and three water abstractions in Germany as well as Hungary. The assessment of pressures on the quantity of the 11 transboundary groundwater bodies of basin-wide importance showed that over-abstraction prevents the achievement of good quantitative status for two ground-water bodies (ICPDR 2009, Table 9).

Projections of water resource requirements for 2015 are included in the DRBD Plan based on national methodologies, and incorporating minimum, average and maximum scenarios. The scenarios identified by all Danube Countries indicate a small increasing trend of water abstraction as a consequence of increases in water demand at basin wide level in industrial, urban and agricultural sectors (although some economic sectors predict reductions in water demand mainly through

[15] As required under Article 5 and Annex II of the Water Framework Directive

technological changes which increase efficiency of water use). Additionally, water abstractions for urban needs will decrease slightly in upstream Danube countries under the analyzed scenarios, whilst there are expected to be small increases in central and lower Danube countries as consequence of increased use of centralized water supplies. Water demand for agriculture is expected to become more significant due to intensification in some regions and anticipated climate changes. Thus it seems likely that the roles that ecosystems play in increasing water availability for human use will increase in future years.

In terms of water quality it appears that the Danube and its tributaries is subject to significant levels of pollution, especially nutrients, the major sources of which are insufficiently treated waste-water discharges from major municipalities. Consequently pollutant concentrations tend to increase from upstream to downstream. According to biological water quality assessments, mainly based on the Saprobic System for detecting biodegradable organic pollution, the Danube is classified as “moderately polluted” (Class II) to “critically polluted” (Class II-III) (ICPDR, 2004). The tributaries are in part highly polluted.

However, there have been some significant improvements in the level of the total nutrient load in the Danube River system since the 1990s as a result of the closure of some industries, significant declines in the use of mineral fertilisers and the closure of large livestock farms (ICPDR, 2009). Waste water treatment is also improving, especially in upstream countries.

According to a study conducted in 2001 and 2002, good water quality for drinking water purposes (without treatment) has only been achieved in the stretch of the Danube between Dettingen and Leipheim (Germany) and Mohacs (Hungary)[16]. However, oxygen levels of the Danube are high enough to normally allow treatment with natural processes, such as bank-filtering or slow sand filtration to reach drinking water quality. Furthermore there have been recent improvements in the chemical and ecological condition of most water bodies in the region, with 193 out of 681 river water bodies that were surveyed in 2007 achieving good ecological status or ecological potential (28%) and 437 river water bodies achieving good chemical status (64%) (ICPDR 2009).

Assessments of groundwater quality reveal that out of 11 transboundary groundwater bodies of DRBD importance (22 national parts evaluated), good chemical status was observed in all national parts of 8 transboundary bodies (73%) (ICPDR 2009). In two additional transboundary groundwater bodies poor chemical status was observed in one national part. In only one were all national parts found to be in poor status.

The overall assessment of pressures on the quality of the 11 transboundary groundwater bodies of basin-wide importance showed that pollution by nitrates from diffuse sources is the key factor affecting the chemical status of these

[16] http://www.icpdr.org/icpdr-pages/water_quality.htm

groundwaters. The major sources of this diffuse pollution are agricultural activities, non-sewered populations and urban land use.

The potential impacts of future land use changes and point and diffuse source nutrient reduction measures is investigated in the DRBD management plan through a model (MONERIS) and scenario bases projections (ICPDR, 2009). The results suggest that under the baseline scenario, which assumes moderate development of the agricultural sector and the implementation of measures foreseen by the countries, nitrogen pollution levels will decrease. Scenarios that include more intensive agricultural development project potentially significant increases in nitrogen pollution in several countries. However, it is considered that the baseline scenario is the most realistic.

Social and economic values

From this brief analysis it is obvious that ecosystems play a key role in providing clean water to the inhabitants of the DRB, as well as for agricultural, and industrial uses, etc. However, it is not possible to calculate the value of these services across the basin or for significant parts of it. This is primarily due to the lack of information available on the contributions that different ecosystems make to water provision and water purification. For example, although we know that grasslands help to retain and clean water and prevent pollution of watercourses, this study has not been able to ascertain the potential impacts of changes in habitat type, such as from semi-natural permanent grasslands to more intensive temporary grasslands on water resource quantity and quality. Nor do we know the costs of alternative methods of obtaining water resources that are lost as a result of ecosystem changes. Although models and technical data may exist to calculate such impacts, such analyses are beyond the scope of this study.

A further problem is that as a result of differing economic, financial and institutional conditions in the Danube countries, water pricing systems vary considerably among the countries and do not necessarily reflect true costs. The application of economic and environmental principles into price setting and the degree of application of cost recovery vary amongst the DRB countries according to their specific legal and socioeconomic conditions.

A number of case studies have attempted to calculate the value of water supplies from national parks, including two in the Danube basin and one in the nearby Tatra Mountains (see Box 3.3.1). These seem to indicate that the values of water provision and regulation services provided by the parks vary from €257 per km^2 per year (Maramures Mountains Natural Park) to €24,948 per km^2 per year (Tatra Mountains National Park). However, these estimates are not necessarily based on full cost recovery pricing of water resources and may therefore underestimate values. But, more importantly, they do not consider the marginal values of the water services provided by the ecosystems and how these would change in response to changes in them. The results may therefore provide misleading information with respect to the potential impacts of ecosystem change.

Box 3.3.1. Estimates of the value of water provision and quality regulation from case studies of ecosystem services in National Parks in Eastern Europe

The Tatra National Park, Poland (source Getzner 2009)

The National Park lies on the border with Slovakia and covers 21,164 ha. Forest ecosystems account for 72% of the area, of which about 58% are natural or semi-natural. The park has numerous water sources, from run-off as well as many springs which provide an annual average of approximately 7m m^3 of fresh water. About 5.5m m^3 are used by the local inhabitants and the tourist industry.

According to actual water tariffs (which may not recover all costs) the value of utilised water amounts to €3.7m per year. Whilst if the springs are fully used for drinking water purposes, the value of water provision would amount to €4.76m per year. Given the current water use of 5.5m m^3 per year, the lower bound amounts to €2.585m (water price €0.47 per m^3), while the upper bound would be €5.28m (water price of €0.96 per m^3).

In addition, water is used in four small hydro-electric power plants inside the national park for local supplies. However, no further information is provided in the case study on its value.

Slovensky Raj (source Getzner 2009)

The National Park lies close to the Tatra National Park along the border between Poland and Slovakia. It comprises a total area of 19,753 ha of core zone, and a buffer (conservation) zone of 13,011 ha. It ranges between 500 to 1,700 m altitude and holds a large diversity of habitats including some 8,000 ha of forest.

Several large springs provide the water supplies for adjacent municipalities which, taken all together, include close to 75,000 residents, where daily household consumption is estimated to be at least 80l per person. On this basis and the assumption that the majority of residents depend on the water supplied from Slovensky Raj National Park, the minimum annual water consumption in the national park region would be approximately 2.19m m^3. Actual water consumption may be higher as the use of water for agricultural or commercial uses is unknown. But a complication is that the majority of residents actually receive their water from the Tatra National Park (see above). The case study therefore assumes that only 30% of residents are supplied by water from Slovensky Raj National Park; in which case, the ecosystems of the park annually provide 0.657m m^3 of fresh water. Given a mean daily consumption of 160 l per person, the park may provide up to 1.314m m^3 of fresh water per year.

Combining the annual water supply with actual water prices of €0.95 per m^3, the value of the ecosystem service of drinking water supply is – at the lower bound – about €624,000 per year (upper bound €1m given a water price of €1.5 per m^3). The author notes that the estimation made above compares favourably with a survey by the Slovensky Raj National Park Authority.

Overall, the estimated value of water provision services in the National Park amount to €1.48m per year (assuming water provision by the park of 1.314m m^3 and a price of €1.1 per m^3). The lower bound amounts to €0.624m (water provision of 0.657m m^3; water price of €0.95 per 28 m^3), the upper bound is €1.971m (water provision of 1.314m m^3 and a water price of €1.5 per m^3).

Maramures Mountains Natural Park, Romania (source Ceroni 2007)

The Natural Park is located in the North-eastern corner of Maramures County in Romaina along the border with Ukraine. It covers some 168,754 ha, of which 60% is forest and the rest if mostly grasslands (pastures and hay meadows).

Water supplies from the park provide drinking water for the local population. Alpina Borsa, a bottled water company based in Borsa, uses water from the park. Some private and government-run fish farms also benefit from clean water in the streams of the National Park.

Local prices for water were 2.05 RON (€0.48) and 1 RON (0.235) per cubic meter for the municipalities of Viseu de Sus and Borsa respectively. Therefore, on the basis of a total use of 1,260,000 m^3 of water in 2006, the value of the water resources amounts to 1,848,000 RON (€434,000).

Conclusions

The availability of adequate clean water is a fundamental human need, and therefore this ecosystem service is vital for all inhabitants of the DRB, for direct domestic use, and also for industry, farming and the maintenance of river levels for fishing and recreation etc. Furthermore, it is clear that the condition of ecosystems has an important influence on the availability and quality of surface and ground water supplies. Therefore, forests and semi-natural habitats that have intact vegetation and low nutrient status soils play a particularly important role in protecting and improving the quantity and quality of water resources.

Current information suggests that the service is being maintained at adequate levels in most regions, although unsustainable abstraction may be occurring in some areas. Such problems may also increase in the future as a result of expected rises in demand for water and the impacts of climate change. Although the Danube has moderate to critical levels of organic pollution water quality within the DRB is generally adequate for most uses, although treatment is often required for drinking supplies. Some water bodies are subject to local pollution problems, which have impacts on water provision and some other ecosystem services such as fish production and recreation. However, pollutants levels are falling and on the basis of planned water pollution control measures, pollution problems are expected to continue decline. But nutrient inputs could increase if agricultural intensification increases more than currently predicted.

Detailed information on the relationship between the condition of ecosystems and the provision of water and regulation of its quality is not readily available. It is therefore not possible to provide estimates of the added values that various types of ecosystem provide in terms of the delivery of clean water for human use etc. The estimation of the value of water services is also further complicated by the fact that water pricing varies considerably amongst the countries of the region and often does not reflect the true costs of its provision (including its environmental externalities).

Table 3.3.2. Estimation of the overall status of water quantity and quality services in the Danube Basin.

CURRENT IMPORTANCE of the ecosystem service	QUALITY / AVAILABILITY of the ecosystem service		REASONS BEHIND CURRENT STATUS & TRENDS
	RECENT TREND	EXPECTED TREND (business as usual)	
Water provision: quantity: Very high	↔	↘	No significant changes in provision observed or likely, but demand likely to increase and water supplies may decline with climate change
Water provision: quality: Very high	↗	↗	Some pollution problems, e.g. from agriculture and industry, but outweighed by pollution control measures

3.4 Flood storage on the Danube floodplain

Description

Where rivers have a natural structure (i.e. hydromorphology), high river discharges, such as from exceptionally heavy rainfall or spring snowmelt, are able to overtop river banks and inundate the floodplain. This results in a reduction in the volume of water in the main river channel and its rate of flow, thereby reducing the peak river level and magnitude of flooding downstream. In addition, natural rivers tend to meander and often pass through marshes and vegetated habitats. Such features further reduce the rate of river flow.

At the same time, regular seasonal flooding typically creates flat fertile soils that are ideal for agricultural production. This, together with the other benefits of the river, such as transport and water resources has therefore commonly led to extensive human settlements and industrial developments on floodplains. But as these developments have arisen, they have increasingly been protected from seasonal flooding by raising natural river banks through the construction of dykes (embankments) or by infilling to raise land levels above flood levels. In addition, river channels are often reengineered to increase flow rates and to improve navigation, etc.

Such flood and river management has been widely carried out in the DRB, resulting in the loss of over 80% of former morphological floodplains over the last 150 years

(UNDP/GEF, 1999), including a 70% loss along the entire Danube (Table 3.4.1). Nearly 90% of the former floodplains along the Tisza River and 70% of the Sava River have been lost (Schwarz, 2006). In fact, for some long stretches of the Lower Tisza and Danube the floodplain losses approach 90%.

Table 3.4.1. Changes in the area of the Danube floodplain (Source: Adapted from Schwarz, *et al*, 2010).

Danube section	Size of floodplain		% Floodplain loss
	Morphological floodplain *1 (km²)	Active floodplain *2, incl. main channel (km²)	
Upper Danube 950 km (DE, AT)	2,831	707	75
Middle Danube 900 km (SK, HU, HR, RS, RO)	10,368	2,143	79
Lower Danube 850 km (RO, BG, MD, UA)	8,033	2,208	73
Danube Delta 100 km (RO, UA)	5,291	3,394	35
Danube total 2,845 km	26,524	8,535	70

Notes: *1. Including the active floodplain (morphological floodplain minus active floodplain is the “former” floodplain). *2. Defined by Schwarz as the floodplain area between current flood defences (dykes), which are often designed for the 100 year flood return interval. All channels are integral to the river-floodplain ecosystem and are therefore included in the calculation. However in heavily altered river reaches the real size of active (semi- and terrestrial habitats) floodplains is no more than half the main channel width, particularly along the large lower Danube where the channel is about 1-2 km wide).

These changes in the floodplain have undoubtedly affected the hydrology of the river, reducing the incidence of regular seasonal flooding, but increasing the risk of occasional severe floods when flood peaks exceed the height of the modified flood banks. This has result in some catastrophic floods, which have claimed lives and had substantial economic and wider social impacts (Table 3.4.2).

Table 3.4.2. The impacts of the 2006 floods on the River Danube (Source: Adapted from Schwarz, 2006).

Danube section	Duration	People	Damage (million €)	Cause	Annuality
1. Upper Danube (DE, AT, CZ)	28.3. - 17.4.	5 dead, 4,000 displaced (mostly in CZ)	~ 110	Snowmelt/rain	Lower Morava and Dye about 100 years event
2. Middle Danube (SK, HU)	28.3. - 28.4.	3 dead, 6,000 displaced	~ 30	Snowmelt and rain and locally dike breaks	About 100 years event for the lower reaches of Bodrog and Tisza and the Danube
3. Middle Danube (CS, HR)	4.4. - 28.4.	2 dead, 3,000 displaced	~ 60	Concurrent high discharges of the Danube, Tisza and Sava	At least 100 years event
4. Lower Danube (RO, BG, MD, UA)	7.4. - 15.6.	14,000 displaced	~ 400	Water from middle Danube, Several dike breaks and controlled flooding	About 100 years event

Flow of service within the Danube Basin

Although much diminished, the remaining active floodplains (i.e. those that still regularly flood) do provide some flood protection to some areas of land and inhabitants along the river (Table 3.4.3). However, the exact magnitude and location of any benefits from flood storage areas will vary according to their capacity, location and level at which they receive flood waters in relation to downstream land and river embankment levels. Consequently some small areas of floodplain will not provide significant benefits because they are too quickly filled by flood waters to have any impact on the flood peak level in the main channel.

Where natural or semi-natural floodplain habitats (e.g. marshlands, wet grasslands, riverine woodlands and shingle banks), do remain they can provide a range of other related ecosystem services, such as habitats for fish, water resource protection (e.g. pollutant filters / barriers), carbon stores and areas for wildlife and recreation that may support tourism etc. The flows of these services are described elsewhere in this report.

Table 3.4.3. Overview of the "flow" of service in the Danube River Basin – flood storage

FLOW OF THE SERVICE			STAKEHOLDERS	
Where is the service produced ?	**Where is the service "enjoyed" ?**	**Scale**	**Who provides / helps to maintain the service ?**	**Who benefits ?**
Active floodplains of the River Danube and its tributaries, which are inundated by floodwaters (including impounded polders / washlands that are used as managed flood storage areas)	Downstream of flood storage areas, with speecfic locations (e.g. towns) benefiting from some upstream flood storage areas	Catchment	River / flood management authorities and landowners	Some inhabitants / land users that are at risk of flooding by the Danube and its tributaries, depending on the specific upstream flood management measures in place and the nature of each flood event.

Status and trends

As described above, the flood storage benefits provided by floodplain ecosystems have now been much reduced as a result of human actions. However, the detrimental impacts of these changes in terms of flooding and losses of other ecosystem services are increasingly being realised. Consequently, a number of studies and proposals have been developed for floodplain restoration with the DRB. A recent study commissioned by WWF reviewed these, and identified 439 existing, planned or proposed restoration projects, with a total area of some 1.38m ha (Schwarz, *et al*, 2006) along Danube River and its main tributaries. Out of this 810,228 ha (196 areas) are on the Danube floodplain, with 179,708 ha (22%) on the active floodplain and 630,520 ha (78%) located on the former floodplain. Of the areas on the former floodplain, 24% have a high potential for restoration (24%). If restored, these areas could reduce the overall loss of the floodplain by 44%, thus significantly increasing the water storage capacity of the floodplain.

Thus, there is clear potential for the restoration of flood storage services. But it is important to note that this need not necessarily result in the restoration of wetlands or other biodiverse habitats and associated ecosystem services. Indeed to be effective many flood storage areas will only flood infrequently and will need to remain dry (to maximise the additional water they can store during floods). Therefore, unless restoration is of a sufficient scale to allow areas to develop wetlands or other semi-natural habitats, overall ecological benefits may be limited. Nevertheless, 8% of the proposed restoration areas of the Danube are in "near-natural" floodplains, including large project sites in the Danube Floodplain National

Park (AT) and Gemenc (HU), which are already partially restored. These sites might therefore be suitable for broader ecosystem and ecosystem service restoration.

The results of the WWF study are encouraging as is the increasing awareness of the importance of floodplain ecosystems services and the potential economic benefits of floodplain restoration (see below). In addition, Schwarz, *et al* note that about 560,000 ha of the 810,228 ha of propose restoration areas are already officially planned according to the Danube River Basin Management Plan (ICPDR, 2009). However, few restoration schemes have been undertaken to date. This is likely to be partly due to their high cost, which is estimated to be on average €500,000/km² for restoration across the basin, though with significantly lower costs on the Lower and Middle Danube (Schwarz *et al*, 2010). Consequently, the overall investment needed to restore all the sites proposed in the study would amount to more than €6 billion across the 13 countries involved. Furthermore, despite the EU Water Framework Directive and Flood Management Directive, the tendency remains for flood protection requirements to be delivered via traditional engineering solutions rather than through ecosystem-based measures (O. Hulea pers comm.). It therefore seems likely that without significant policy changes and investment, the value of this flood mitigation service on floodplains in the region will continue to decrease overall, at least in the short-term.

Social and economic values

As described in Section 3.1 calculations of the value of floodplain ecosystems have been made on the basis of all their main ecosystem services, e.g. relating to fish production, carbon and tourism. On this basis the average economic values of floodplains in the lower Danube region are considered to be around €500 per ha (Schwarz *et al*, 2006). This suggests that floodplain restoration may be economically worthwhile given that average capital restoration costs are €5,000 per ha. But as noted above, floodplain storage areas may entail a wide range of habitats, from intensive farmland to wetland habitats, which will therefore vary greatly in their ecosystem service benefits. Furthermore, some of ecosystem service benefits may be difficult or time-consuming to restore. Thus, the relationship between flood mitigation benefits from floodplain restoration and overall floodplain ecosystem service values is unclear.

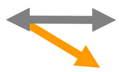
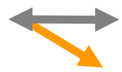
Assessment of the economic value of flood mitigation per se is also difficult because benefits will vary greatly according to context, in particular the potential costs of flood damage and the degree to which ecosystem restoration may reduce damage. Such an assessment is therefore beyond the scope of this study.

Conclusions

The impacts of widespread flood engineering works and developments within river floodplains in the DRB have clearly had major impacts on ecosystem services in the region. Most notably, such works have exacerbated recent floods that have costs lives and resulted in serious economic and social impacts. However, there remain opportunities to reverse some of these ecosystem service losses through floodplain and river restoration measures. Furthermore, depending on the scale and location of floodplain restoration measures, some wetland habitat restoration or creation may result in biodiversity benefits which could in turn support other ecosystem services relating to fisheries, carbon, water resources and tourism.

However, floodplain restoration measures need to be on a large scale to provide significant ecosystem service benefits and it is not clear if the resources and political will is currently available to take such schemes forward.

Table 3.4.2. Estimation of the overall status of flood storage services on the Danube Basin floodplain.

ECOSYSTEM SERVICE	IMPORTANCE of the ecosystem service		QUALITY/AVAILABILITY of the ecosystem service	
	Current	**Future**	**Current trend**	**Future trend given "business as usual"**
FLOOD PREVENTION	LOW	INCREASING		

3.5 Climate regulation – carbon sequestration and storage

Description

The carbon cycle refers to the movement of carbon between the atmosphere, land, oceans, and organisms (Post and Kwon, 2000). A large proportion of global carbon stocks are within vegetation (in forests, grasslands, marine algae) and soils (especially peatlands). However, these stores are declining as a result of forest loss and soil degradation, which is leading to higher concentrations of carbon dioxide in the atmosphere, contributing to climate change (IPCC, 2007). Consequently the value of maintaining existing carbon stores and sequestration is becoming increasingly recognised. Therefore, it is important to analyse the role of carbon sequestration and storage in the soil and vegetation as this provides an ecosystem service through climate change mitigation.

The volume of carbon stored in the soil, known as soil organic carbon (or SOC), varies depending on the type of soil and land use. Soil organic carbon tends to be high where there is a net input of carbon through the creation and subsequent deposition of organic matter (sequestration). The equation can be balanced by net losses of SOC through processes such as dissolution, erosion, and fire (Smith, 2008).

With their large organic inputs, forests and grasslands sequester and store carbon well. Cropland, however, has short growing periods followed by large scale biomass harvest, and so has only weak carbon inputs. This situation is further exacerbated by the loss of SOC through intensive soil management practices such as tillage. This exposes organic carbon to eroding processes while also altering the soil temperature regime, which affects important soil fauna communities (Schulp *et al*, 2008).

Indeed the loss of SOC is a particularly important issue in Europe. Since 1980, it is estimated that the organic carbon content of arable and rotational grass soils has declined by 15% on average, while soils in agriculturally managed semi-natural land have lost 23% (EASAC, 2009). This indicates that the ecosystem service of carbon storage is deteriorating, leading to higher levels of carbon in the other components of the carbon cycle, such as the atmosphere, while also reducing the productivity of the soils and increasing their vulnerability to erosion.

However, European forests are important in carbon sequestration, drawing this greenhouse gas down from the atmosphere into organic form, before returning it to the soil stores as vegetation decomposes. Indeed, Europe's forests are estimated to annually sequester 124g C per m^2 from the atmosphere (Janssens *et al*, 2005), and during the 1990's the continent was believed to be a terrestrial carbon sink to the magnitude of 0.1-0.2 Pg C per year (Janssens *et al*, 2003). Recent studies have also shown that old-growth forests are particularly important in terms of their ability to store carbon, as well as their high biodiversity values (e.g. Keeton, *et al* 2010).

Flow of service within the Danube Basin

The flow of the Danube Basin's carbon sequestration and storage services are summarised in Table 3.5.1 below.

Table 3.5.1. Overview of the "flow" of service in the Danube Basin – Carbon storage and sequestration

FLOW OF THE SERVICE			STAKEHOLDERS	
Where is the service produced ?	**Where is the service "enjoyed" ?**	**Scale**	**Who provides / helps to maintain the service ?**	**Who benefits ?**
Forested areas of the Danube Basin	Carbon sequestration benefits the global community	Global	Local landowners	The global community
Soil carbon storage in arable areas	Carbon in the soil improves agricultural productivity	Local	Local landowners and farmers	The regional community and economy

Status and trends

In much of the Danube Basin, soils are reported to be in poor condition due to erosion, pH changes, salt content fluctuations and compaction. For example, in Romania, which accounts for a quarter of the land within the Basin, soil degradation through water erosion is believed to affect more than 7m ha of agricultural land (Government of Romania, Ministry of Agriculture, Forests and Rural Development, 2006). It is estimated that up to 126mt of soil are lost annually to erosion, with particularly severe losses in the Moldavian uplands, sub-Carpathian hills, Getic uplands, and Transylvanian Depression. As a result, the soil carbon store in Romania is believed to lose 30.7 g C per m^2 per year from croplands and a further 0.2 g C per m^2 per year from wetlands, thereby weakening the provision of this ecosystem service. However this is balanced by the sequestration of 11.1 g C per m^2 per year by pastural areas and 56.4 g C per m^2 per year by the country's 6,382,000 ha of forest, making Romania a net sink of 36.6 g C per m^2 per year (Janssens *et al*, 2005).

The situation in Romania is typical of countries with large areas of forest and other semi-natural habitats. But others which are dominated by intensive agriculture are likely to be net emitters. For example Hungary, which has the second largest area drained by the Danube and has increased its total forest cover from 1,801,000 ha in 1990 to 1,976,000 ha in 2005 (FAO, 2005), still acts as a net terrestrial carbon source rather than sink. This is because Hungary's extensive cropland area means that the carbon these forests sequestrate (37.5 g C per m^2 per year) is outweighed by the soil carbon lost from agricultural land management (-44.8 g per m^2 per year) (Janssens *et al*, 2005).

It is therefore unclear whether or not the Danube Basin is currently a net sink and store of carbon. However, it is clear that the strength of this ecosystem service could deteriorate if it follows recent EU patterns of land use change. As described in Section 2.2 above, it is widely expected that further agricultural intensification will occur, especially in the new EU Member States (IEEP and Alterra, 2010). This could lead to the expansion of croplands at the expense of semi-natural grasslands and so will result in greater soil loss from more frequent tillage. Indeed, Schröter and colleagues (Schröter *et al*, 2005) estimate that increasing cropland will reduce Europe's soil organic carbon level in 2030 by 4.3-5.8 Pg C compared with a 1990 baseline, depending on which IPCC storyline and climate model are used. This could be offset to some extent by land abandonment resulting in forest regeneration. However, the areas involved are less certain and are likely to be smaller than the areas subject to intensification, with Schröter *et al*. estimating that forests will only increase their organic carbon store by 0.7-2.8 Pg C in 2030 compared to 1990. It is also worth noting that extreme weather events such as droughts and floods are predicted to increase with climate change, and so their effects on soils are likely to be enhanced in the future.

The conversion of forest areas to croplands could be a potentially serious threat because of the significant role forests play in storing and sequestering carbon. This type of land use change has been a major concern in Romania following the privatisation of land after end of communism, coupled with the country's sudden exposure to capital markets following Romania's recent accession to the EU.

However, aside from small scale illegal logging recent trends have been of forest expansion (see Section 2.2), and the Romanian government aims to expand the area of forested land from 27% to 32%. The threat of conversion to cropland is also reduced as 93.3% of Romania's forest is located in areas with high relief (Government of Romania, Ministry of Agriculture, Forests and Rural Development, 2006). But the logging and replanting of old-growth forest would significantly reduce current carbon stores, as well as having significant impacts on biodiversity and associated ecosystem services.

Social and economic values

While it is clear that the soils and forests of the Danube Basin are providing an important ecosystem function in the form of carbon sequestration and storage, little work has been done on the precise valuation of these services. This is a challenging task as the service must be measured for several small regions of many countries, and because the beneficiaries from this service are global rather than local.

As described in Section 3.1, Ceroni (2007) estimated the value of terrestrial carbon stores in Romania's Maramures National Park, finding it to vary between 26m RON (about 6m Euro) to 172m RON (about 40m Euro) depending on whether carbon value was based on trading rates (the lower estimate) or higher social values. At a larger scale, even when we have a figure indicating that Romania provides a net carbon sink of 36.6 g C m^{-2} yr^{-1}, the total value of that regulation role depends on assumptions about appropriate discount rates and the social value of carbon. If we assume that Romania does indeed sequester 36.6g C per m^2 per year, and take the average carbon price in the first half of 2010 (H1 2010= €12.97 per t C), then we can estimate that this ecosystem service has a current value of 110m Euro per year (see Appendix 1). Of course adding all of this sequestered carbon to international markets would cause an increase in supply and so could reduce the carbon price, but it does at least provide a relative figure to gauge the magnitude of this ecosystem service.

If similar calculations are done for all countries in the Danube Basin, using the net carbon balance data provided by Janssens *et al*. (2005) and each country's land area within the Danube Basin (as supplied by the ICPDR[17], the value for the Basin's annual carbon sequestration at 2010 H1 prices is €29m. There are likely to be some errors in this calculation as countries such as Albania, that only have a small proportion in the Danube Basin, are unlikely to have the same net carbon balance as the country as a whole, but the overall magnitude of values are likely to be reliable.

This lower carbon sequestration value of €29m per year is a result of the large areas of carbon emitting cropland in Hungary, Moldova, and Ukraine. This analysis provides support for the recommendation that European countries should improve the management of their cultivated soils to potentially double their sequestration abilities (Smith, 2004).

[17] http://www.icpdr.org/icpdr-pages/countries.htm

It is also possible to give rough figures for projected changes in terrestrial carbon emissions in the Danube Basin following land use change. While these figures are very crude estimations, they do provide an idea about the magnitude of potential change to the region's net carbon balance. Therefore the projected land use changes in cropland, grassland, and forests for ten Danube Basin countries (accounting for 72% of the Basin's area) were taken from the model projections of IEEP and Alterra (2010) – see Section 2.1 above. These were incorporated with Janssens *et al* (2005) findings and then were cross-checked against Schröter and colleagues' (2005) predictions for Europe as a whole. The results indicate that decreasing areas of cropland in the Danube Basin, as predicted under the IPCC's B1 scenario, will potentially save 4.8mt C, but this depends on what the cropland is converted into. The reduction in the area of grassland in the sampled countries is predicted to result in 130,000t C more emissions in 2030, but the increase in forestry is expected to draw down and store 875,000t C. Overall, these calculations suggest that land use change in this part of the Danube Basin will improve the strength of this ecosystem service, storing around 1.2mt C in terrestrial sources.

Conclusions

Although it is difficult to measure the socio-economic value of carbon sequestration carried out by the soils, grasslands, wetlands and forests of the DRB, it is unlikely that this service is deteriorating at a significant pace, primarily as a result of afforestation compensating for SOC losses from increased agricultural intensification. Therefore it is important that the region's forests, and particularly their old-growth forests, are conserved so that they can continue to provide this globally important ecosystem service.

However, the ongoing losses of SOC through soil erosion, and in particular from flooding, are a major threat to the area's carbon storage capacity. This is an even more pertinent issue if predictions of increases in both the magnitude and frequency of floods and other extreme weather events as a result of climate change in continental Europe are taken into account.

Table 3.5.2. Estimation of the overall status of carbon storage and sequestration in the Danube Basin.

CURRENT IMPORTANCE of the ecosystem service	QUALITY / AVAILABILITY of the ecosystem service		REASONS BEHIND CURRENT STATUS & TRENDS
	RECENT TREND	EXPECTED TREND (business as usual)	
Forest Sequestration: High	↔	↔	No major forest losses have occurred over the last 20 years, although some losses of carbon-rich old-growth forests
Forest Storage: Very High	↔	↗	No major forest losses have occurred over the last 20 years, expansion of forest areas is likely in many countries due to afforestation programmes and agricultural abandonment
Soil Sequestration: Moderate	↔	↘	No major changes in soil sequestration have been reported, but increasing agricultural intensification and climate change are threats
Soil Storage: High	↘	↘	Many soils are prone to erosion and this may be exacerbated by increasing agricultural intensification and climate change

3.6 Nature-based tourism and recreation

Description

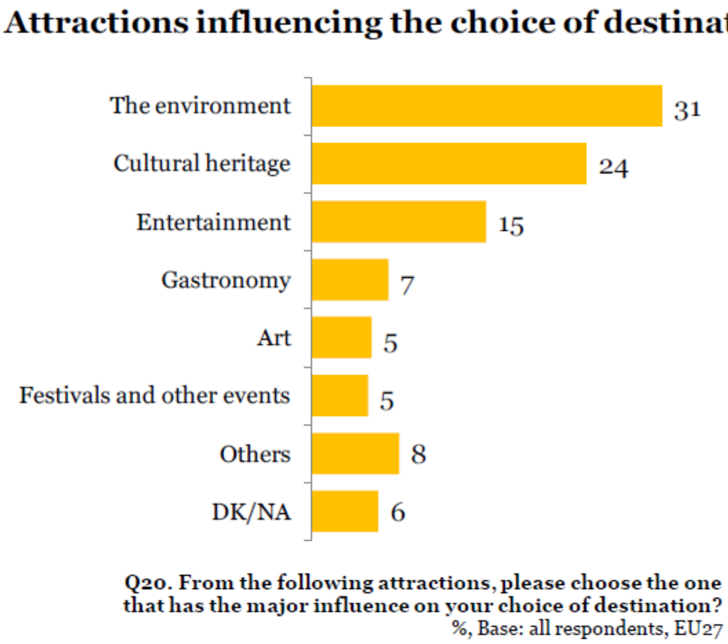
The tourism and recreation industries constitute important economic sectors within the EU, where tourism produced 5% directly and 10% indirectly of European GDP in 2008 (Eurostat, 2009). DRB countries represent important potential growth areas for tourism, particularly in the Eastern European nations (WTTC, 2009; WTTC, 2006). Tourism provides a source of revenue which is often highly dependent on natural and cultural services, such as the protection of natural areas, maintenance of cultural heritage and the provision of valuable landscapes.

It is the determination of the component of tourism that is dependent on nature (i.e. ecosystems and associated landscapes, habitats and species) that is of most interest in this study. It is therefore relevant to note that a recent Eurobarometer survey (Eurobarometer, 2009) found that a location's environment is the most important consideration in people's decisions on where to visit (see Figure 3.6.1). In an earlier study, the scenery was cited as the most important criteria for selecting a destination with 49% of interviewees, ahead of climate at 45% (Eurobarometer, 1998).

Further evidence of the importance of the natural environment is in the growth of the outdoor recreation sector which is particularly dependent on natural resources (TEEB, 2009). This is distinguished in two ways, eco-tourism and nature-based tourism. Eco-tourism stipulates that the net impact of travel on the environment and on local people must be positive. Nature-based tourism (i.e. travel to unspoilt places to experience and enjoy nature) focuses more on what the tourist can gain and less on ensuring that natural areas are protected (TEEB, 2009).

Attitudes towards the importance of clean and natural environment appear to be growing.

Figure 3.6.1. Attraction influencing the choice of destination of Europeans



Source: Eurobarometer (2009)

Flow of service within the Danube Basin

The cultural, recreational and spiritual services which provide the basis for the tourism industry are principally enjoyed by those who directly visit the site in contrast to services such as carbon sequestration which have global benefits. The benefits from tourism associated with natural areas are delivered through the receipts of payments into the local economy, which enables a rough estimate to be made of who benefits from National Statistics data.

National Statistics data from the respective countries provides the numbers of visitors that bordering states attract each year. There are differences between the countries in terms of the provenance of tourists. Foreign tourism is particularly underdeveloped in Romania, where domestic tourism accounts for close to 80% of arrivals and over 80% of overnight stays made. Baden-Württemberg in Germany, where the Danube rises shows a similar situation. In most other nations, these figures are reversed, with tourists predominately coming from abroad (See Table 3.6.1).

Table 3.6.1. Numbers of arrivals and overnight stays in 5 Danube neighbouring countries/regions.

Country / region	Year (latest avail-able)	Arrivals (thousands of tourists)			Overnight stays (thousands of tourists)		
		Total	National (%)	Foreign (%)	Total	National (%)	Foreign (%)
Austria	2009	-	-	-	124.3	28%	72%
Croatia	2009	10,935	15%	85%	56,301	10%	90%
Montenegro	2008	1,188	13%	87%	7,795	11%	89%
Baden-Württemberg, Germany	2009	16,053	80%	20%	43,617	83%	17%
Romania	2009	6,141	79%	21%	17,325	85%	15%

Source: National Statistics Offices.[18] The arrival of a tourist in an establishment is when a person signs in the register of the respective establishment for one night or several nights' accommodation. An overnight stay means the 24-hour interval, starting with the admission hour of the respective establishment, for which a person signs in the register of the establishment, even if the actual stay lasts less than the mentioned interval.

Table 3.6.2. Overview of the "flow" of tourism services in the Danube River Basin

Flow of the service			Stakeholders	
Where is the service produced?	Where is the service "enjoyed"?	Scale	Who provides / helps to maintain the service?	Who benefits?
National parks / Regional parks	National tourists majority Foreign tourists predominately European	National & Transnational	Federal governments / Regional governments	Local tourist service economy
Mountain ecosystems	National tourists majority Foreign tourists predominately European	National & Transnational		Local tourist service economy, ski resorts, hotel chains

[18] Austria: http://www.statistik.at/web_en/statistics/tourism/index.html
Croatia: http://www.dzs.hr/default_e.htm
Montenegro: http://www.monstat.org/EngPublikacije.htm
Baden-Württemberg: http://www.statistik-portal.de/Statistik-Portal/de_jb15_jahrtab32.asp
Romania: http://www.insse.ro/cms/rw/pages/comunicate/arhivaTurism.en.do

Flow of the service			Stakeholders	
Where is the service produced?	**Where is the service "enjoyed"?**	**Scale**	**Who provides / helps to maintain the service?**	**Who benefits?**
Agri-tourism	National tourists majority Foreign tourists predominately European	National & Transnational	Federal governments & European Union through CAP payments Rural farmers	Rural economy
Landscapes	National tourists majority Foreign tourists predominately European	National & Transnational	Federal governments & European Union through CAP payments Rural farmers	Rural economy, local tourist service economy
Water ecosystems	National tourists majority Foreign tourists predominately European	National & Transnational	Federal governments, farmers	Local tourist economy, hotel chains

Notes: *1.

Status and trends

Tourism activity has been rising steadily in border countries in the past decade. Austria, for example, has seen a 20% increase in arrivals and an 8% increase in overnight stays between 2001 and 2009, despite the recession and marginal dip since 2008. Internationally, the global recession took its toll on tourism in 2009, with a 5.7% decrease in receipts on 2008 to €611 billion but 2010 has seen an initial recovery (UNWTO, 2010). Overall, Europe accounted for 48% of the international tourism receipts in 2009.

The development of tourism varies amongst the countries. In 2006, the World Travel and Tourism Council, cited Romania as one of the least tourism intensive countries in terms of contribution of travel and tourism to GDP and total employment (at 4.8% of GDP and 5.8% of the total employment in 2005 in both direct and indirect employment) (WTTC, 2006). In its assessment of its growth prospects, the World Travel and Tourism Council recognise the 'rich cultural and natural diversity' as a major asset of the country which it needs to develop (WTTC, 2006).

Table 3.6.3. Tourism receipts from a selection of Danube bordering countries from 2006 – 2009.

Tourism Receipts (€ million) (ranked in order of highest receipts in 2009)*				
	2006	2007	2008	2009
Germany	25,644	28,178	30,377	26,940
Austria	12,890	14,642	16,750	14,393
Croatia	6,238	7,208	7,917	7,337
Czech Republic	4,326	5,182	6,546	5,659
Hungary	3,321	3,700	3,681	3,003
Bulgaria	2,038	2,149	2,547	2,310
Slovenia	1,403	1,732	2,076	2,197
Slovakia	1,181	1,582	1,802	1,705
Romania	1,021	1,145	1,241	944
Bosnia-Herzegovina	474	569	650	611

Source: http://www.icpdr.org/icpdr-pages/water_quality.htm
* Converted from US$ to € at $1 = €0.78072 (1 September 2010).

Social and economic values

The attempt to evaluate the value generated from cultural and spiritual services of ecosystems through tourism is complicated by the difficulty in determining the reason why tourists are attracted to an area and how much of the reason for visiting an area can be attributed to the ecosystems that are present. A visit to a natural area may be made because of its physical features, such as the view of a mountain range or presence of a beach, which will remain relatively undamaged by the conversion of natural ecosystems. However, the assessment of the income generated through visits to national parks and natural areas can be used as an approximation of the cultural and spiritual services of ecosystems.

Overall, data for the income generated by tourism based on ecosystem services in the study area was not available for this study, but a number of case studies illustrate the potential of natural areas to contribute to the local economy (see Boxes 3.6.1-3). In addition, national statistics in some countries provide estimates on where overnight stays occur. In this case, it is possible to estimate which areas are responsible for income generation.

A report by WWF (1995) found that nature-tourism, understood in this case as travel to relatively undisturbed or uncontaminated natural areas, constitutes about 15% of all tourism. This could be described as broadly equivalent to the generation of tourism in Romania (Table 3.6.4) assuming that tourists to the mountains and the Danube Delta are necessarily attracted by the natural landscapes and biodiversity, which may not be the case.

Table 3.6.4. Estimate generation of tourism income from tourist areas

Destination	**Percentage of overnight stays[a]**	**Total national contribution of tourism (€ million)[b]**	**Income generated per destination (€ million) (a x b)**
Danube Delta, including Tulcea	1.4%	€1,241	€17.4
Mountains	14.0%		€173.7
Principle cities	47.2%		€585.8
Coastal resorts	11.7%		€145.2
Other tourist resorts	15.5%		€192.4
Spa/health resorts	10.2%		€126.6

Sources:
a. http://www.insse.ro/cms/files/statistici/comunicate/turism/a08/turism12e08.pdf
b. http://www.euromonitor.com/countryfolders.aspx

Using the WWF (1995) estimate, an approximate calculation of the income generated by tourism based on ecosystem services could be made by taking the proportion of land within the DRB and multiplying it by 15% of the tourism of the bordering nations (Table 3.6.5). This suggests that total nature based tourism in the 10 studied DRB countries is worth at least €711 million per year. However, this analysis must be taken as a preliminary assessment as it does not describe the proportion of nature-based tourism specific to the countries in question. More recent figures on nature-based tourism per nation are needed.

Table 3.6.5 Estimate of nature-based tourism values

	Tourism Receipts 2009 (€ million) (A)	Nature-based tourism (€ million) (B = A*0.15)	% of country in DRB (C)	Approximate value of nature-based tourism (€ million) (B*C)
Germany	26,940	4,041	7	283
Austria	14,393	2,159	10	216
Croatia	7,337	1,101	4.4	48
Czech Republic	5,659	849	2.9	25
Hungary	3,003	450	11.6	52
Bulgaria	2,310	347	5.9	20
Slovenia	2,197	330	2	7
Slovakia	1,705	256	5.9	15
Romania	944	142	29	41
Bosnia-Herzegovina	611	92	4.6	4
Total	**65,099**	**9,765**	**n/a**	**711**

Box 3.6.1. Income generated for the rural economy from Altmuhlthal National Park, Germany

Atlmuhltahl National Park is located in the Upper Danube region in Bavaria and at 2,900km^2 is Germany's largest National Park. It attracts a mainly German tourist base for nature-based recreational activities, and cultural attractions. In 2008, direct receipts from tourism into the area were €311.2 million: with overnight stays bring in €181.4 million over the course of the year, and day visits accounting for an additional €129.8 million. Overall, guest trade (accommodation, food and drink) accounts for 60% of the earnings, retail trade 25% and other services 15%. This represents €10,731 generated per km^2 of national park although this is attributable to a combination of cultural and natural attractions.

Source: Altmuhltal National Park, Annual Review 2009

Box 3.6.2. A valuation of the economic contribution of tourists to Maramures Mountains National Park, Romania

A study by Ceroni (2007) on the value of key ecosystem services in the Maramures Mountains National Park included interviews in the Vaser Valley, one of the most visited parts of the national park, to gather data on tourist spending and on the non-use values of wildlife, traditional landscapes and cultural heritage. Assuming that the survey of 131 people is representative of the 10,000 visitors who visited Maramures during the tourist season of 2007, 4,835,000 RON (€1,134,332)* were contributed to the local economy in 2007. However, in comparison with forestry, the annual economic contribution of tourism from the Vaser Valley, which covers one third of the area of the National Park, is one sixth of the timber revenues generated across the whole surface of the park.

When asked about willingness to pay extra per night for accommodation that maintained local character and had lower impact on the environment, 91% percent of all respondents answered positively. The average extra amount differed among the visitor groups, with Romanians willing to pay the highest amount, corresponding to almost twice as much they were already paying. Romanians showed the highest appreciation for the steam train in the Vaser Valley and wildlife. Western Europeans appreciated the rural way of life and hayfields, while Eastern Europeans didn't show clear preferences but with possibly more enjoyment of the large expanses of forests.

Respondents were asked to express their interest and willingness to pay for three conservation programs addressing the priorities of preserving endangered wildlife species, hayfields (as a landmark of traditional landscapes), and local culture and traditions in Maramures. Willingness to pay for conservation of wildlife received the most positive responses, with total amounts from visitors (assuming the survey is representative of the 10,000 visitors) from 405,127 RON (€95,160)* for wildlife, compared to 374,232 RON (€87,903)* for cultural heritage and 293,540 RON (€68,852)* for traditional landscapes.

Source: Ceroni, 2007

* 1 RON = €0.234609 [1-Sep-2010]

Box 3.6.3. Economic and cultural values related to Slovensky Raj National Park, Slovakia

A study by Getzner (2009) investigates the ecosystem services provided by the Slovensky Raj National Park in Slovakia, including recreational values and the willingness to pay (WTP) for the protection of the park. The park is known for its caves, gorges, and rich biodiversity (including wolves, lynx and bears) and attracts on average 700,000 visitors per year. The study used total spending per visitor to estimate the recreational value of the park (i.e. the benefit accrued by those visiting the park) as €153 million per year, calculated by estimating the money spent on travel, accommodation and subsistence costs. Willingness to pay for sustaining the park's species conservation programmes amounted to €76 million per year, or approximately one third of the benefits provided by the park.

Sources: Getzner, 2009

Conclusions

Despite the data limitations, it is obvious from this review of evidence that nature-based tourism is of substantial economic value in the DRB. Furthermore, the value of nature-based and eco-tourism appears to be rising with increasing importance being placed on nature and the environment by European tourists. Increasingly, outdoor recreation is being utilised as a manner of attracting tourists to an area. Romania, in particular, has considerable potential for growth in this area, as it is host to considerable natural diversity and heritage with an under-developed infrastructure for tourism.

It is also evident that the attractiveness of many key sites and the wider countryside to tourists could be reduced by habitat degradation and species loss, resulting in reduced nature-based tourism values. Many visitors are drawn to particular sites (such as National Parks) on the basis of their wild landscapes or the presence of certain rare and charismatic species (such as bears in the Carpathian Mountains and pelicans in the Danube delta). However, the exact relationship between the economic value of nature-based tourism and environmental components and quality is not well known and is therefore an important subject for further study.

Table 3.6.6. Estimation of the overall status of nature-based tourism in the Danube Basin.

CURRENT IMPORTANCE of the ecosystem service	QUALITY / AVAILABILITY of the ecosystem service		**REASONS BEHIND CURRENT STATUS & TRENDS**
	RECENT TREND	**EXPECTED TREND** business as usual	
Contribution of tourism from natural areas: Moderate	↔	↗	Tourism and eco-tourism in particular have been on the increase in the past decade, although the recession has returned tourism to roughly 2006 levels. Forecasts for next ten years are positive with appropriate management of protected areas, etc. and growing infrastructure in place in Eastern European countries where tourism remains under-developed..

4 THE POTENTIAL FOR POLICY AND ECONOMIC INSTRUMENTS TO MAINTAIN ECOSYSTEM SERVICES

The EU has a relatively comprehensive environmental policy framework, many components of which may help to support the protection, sustainable use and restoration of the key ecosystem services in the DRB. For example, instruments that aim to prevent the deterioration of environmental quality, such as regulations concerning the use of natural resources (e.g. water), Strategic Environmental Assessment (SEA) and Environmental Impact Assessment (EIA) also support to some extent the maintenance of broader ecosystems and their natural functions. Furthermore, existing policies that are targeted towards the conservation of biodiversity (e.g. protection of habitats and species) help to maintain the overall quality of ecosystems and their services. For example, in the DRB countries that are EU Member States, the achievement of favourable conservation status of species and habitats of Community importance, as required under the Birds and Habitats Directives, can provide broader ecosystem benefits beyond the targeted species and habitats, such as by reducing generic threats such as pollution, hydrological change and habitat fragmentation (Kettunen *et al*, 2010). Consequently, the EU nature directives contribute significantly to the maintenance of healthy ecosystems and related services in the EU. Similarly, the Water Framework Directive (WFD) provides for opportunities to maintain and enhance ecological coherence and the connectivity of inland water ecosystems, including river basins, thereby helping to a safeguard the structure and functioning of such ecosystems in several DRB countries.

However, despite the rather extensive existing policy frameworks for environmental protection and biodiversity conservation (especially in the DRB countries that are EU Member States) a number of short comings still can be found in terms of guaranteeing the quality and continued supply of ecosystem services in the region. An assessment of the existing policy framework was therefore carried out in this study, to identify gaps and potential economic instruments that could be used to address these. The resulting policy matrix is provided in Appendix 1, and summarised below in Section 4.1. This analysis focuses on the EU policy framework, and therefore does not apply across the whole DRB as not all the countries are part of the EU (although it should be noted that all Danube countries have committed themselves to the development and implementation of the Danube River Basin Management Plan, in line with the EU Water Framework Directive). This scoping study does not allow for a detailed assessment of the national policy frameworks in the non-EU countries. Nevertheless, it is generally considered that the status of environmental protection and the conservation of biodiversity and ecosystems in these countries could benefit from improved implementation of existing policies and possibly additional complementary, targeted policy measures.

Following on from the following review, Section 4.3 and Table 4.2.1 provide an analysis of the data needed for further economic assessments and implementation of existing and new policy instruments for the conservation and restoration of ecosystem services in the DRB.

4.1 The existing policy framework and measures for ecosystem services - gaps and implementation needs

It has been widely acknowledged that the implementation of some existing environmental policy instruments in the EU has been slow and inadequate, largely as a result of insufficient financial resources being available (Kettunen *et al*, 2010; IEEP 2010). Furthermore, even though consideration of ecosystem services has featured prominently in the recent biodiversity conservation agenda, existing policy instruments, e.g. the policy approaches and tools available in the DRB, are not targeted towards conserving broader ecosystems and their services. Therefore, whilst they address a range of ecosystem attributes that are important for, or even fundamental to, the maintenance of ecosystem services (e.g. protecting the diversity of species and quality of watersheds) none of the measures comprehensively and systematically conserve the range of socio-economic benefits arising from the natural functioning of the Danube basin ecosystems.

The integration of the values of nature and ecosystem services into policy-making is also hindered by the fact that in the DRB, and elsewhere in Europe, there are no commonly adopted indicators that systematically monitor both the importance and status of ecosystem services. Consequently, as discussed in Section 4.2 below, it is currently difficult to quantify the value and welfare benefits of these services at national and basin-wide levels. In addition, without more holistic monitoring of key ecosystem services it is difficult to determine what the impacts are of promoting one service over another. For example, in the past the damming of the rivers for water supplies has resulted in severe negative impacts on fish stocks, but the economic impacts of such impacts are not well understood. Therefore such impacts tend to be overlooked.

Finally, sustainable management of ecosystems and their services, with due benefits to biodiversity, requires that all relevant sectoral policies work together in a coherent manner, and aim to maintain the quality of ecosystems and their ability to supply their full range of ecosystem services. Unfortunately, however, a lack of policy coherence and integration has been recognised as one of the key failures that drives the continued degradation of ecosystems and their services, both in the DRB and elsewhere. Despite attempts to remove environmentally harmful subsidies a range of policies still seem to contribute to the unsustainable long-term use of ecosystems. Furthermore, the lack of coherence between different sectoral policies also hinders the potential for creating significant synergies and cost-effective policy solutions between the conservation of ecosystem services and other policy agendas. For example, the conservation and restoration of well-functioning ecosystems can support climate mitigation (e.g. by increasing natural carbon stores) and ecosystem based adaptation to climate change (Ad Hoc Technical Expert Group on Biodiversity and Climate Change, 2008a,b; Paterson *et al*, 2008, AHEWG, 2009) and it can also contribute to maintaining food security, such as restoring fish stocks in the Danube river.

4.2 The existing evidence base for the value of ecosystem services - data needs and opportunities for further economic assessments

There is clear evidence from a number of national and more local cases studies of the value of biodiversity, ecosystems and their services in the DRB. However, further analysis is constrained by inadequate data, in two respects in particular. Firstly, basin-wide assessments of key ecosystem services in the region are hindered by a lack of existing information on the value of these services at a wider basin / sub-basin level (e.g. regarding their monetary value). For example, a range of case examples can be found indicating that tourism in national parks and other protected areas can bring benefits to both biodiversity and people. However, no national level data seem to be available on overall visitor flows to these areas or their revenues.

Furthermore, in cases where national level information and indicators are available it is still difficult to determine what proportion of the identified value can be attributed to ecosystems and biodiversity. For example, information is available on the overall fish catch and consumption in the DRB, however no clear indication is given on how much of this fish catch comes from the rivers in the region.

Secondly, little detailed information is available on the relationship between the ecosystem services provided and the ecological properties of the ecosystems involved, such as their species composition. In fact, our lack of understanding of the relationships between service provision and biodiversity itself is a general limitation on our ability to assess the impacts of ecological change on ecosystem services that extends beyond the DRB (Balmford *et al*, 2008; EASAC, 2009). For example, as indicated in Section 3.3 above, there is little detailed information on the role that different ecosystems and ecosystem conditions play in water retention and purification service. Nor is it clear what proportion of the water usage in the DRB and different countries in the basin is reliant on ecosystem purification (i.e. where there is no / limited investment in artificial water purification).

Similarly, in terms of tourism, it is not possible to distinguish between different motivations behind tourism, i.e. whether visitors are drawn to national parks based on the general beauty of landscapes or also due to the diversity of species and habitats they have to offer. Of these two, the latter could be taken as a more accurate indication of their "true" biodiversity value.

Given the above, it is foreseen that more effort (e.g. systematic, basin-wide and service-specific assessments) is required to quantify and/or monetise the value of key ecosystem services in the wider Danube context. Table 4.2.1 below therefore provides an overview of the data that would be needed to carry out a more comprehensive economic assessment of ecosystem services within the DRB. However, in the interim the information already available provides a solid starting point for demonstrating the socio-economic importance of ecosystem services in the basin and integrating these considerations into the decision-making, e.g. initiating further thinking on the use of economic approaches and tools outlined in 4.3 below.

Table 4.2.1. Overview of data gaps and needs for further economic assessments of key ecosystem services in the Danube River Basin.

Key ecosystem service	Rationale	Level of assessment	Data needs	Data available	Data gaps
Provisioning services					
Fisheries (natural river fisheries)	There has been a decline in fish catch due to conversion of floodplain ecosystems / reed banks. Therefore, restoration of ecosystems could help to increase sustainable fisheries in the DRB.	Regional Local examples to showcase important local benefits.	Current fish catch from the DRB (amount & value). Trends in fish catch (e.g. past vs. current vs. future with restoration). Data on people / communities / jobs depending on fisheries.	General information on fish catch / production in the DRB, with no differentiation between fish catch from the Danube River / Delta and elsewhere (e.g. Black Sea).	Current and historical fish catch data that can be attributed to specific rivers and sections. Data on benefits related to DRB fishing, e.g. number of people / communities / jobs depending on fisheries. Finally, if information on fish catch originating from the Danube Delta is found, an indication is also needed whether these fishing activities are carried out on a sustainable basis.
Water: provisioning	There is a need to gain a more holistic picture of the provisioning of clean water in the whole DRB. This includes: assessing the "flow of service", taking into consideration catchment ecosystems and their land use; establishing the roles of different stakeholders, i.e.	Regional: upper / mid / delta and the whole basin. Local examples to showcase important local benefits.	Detailed information of water provisioning in / between different areas of the basin (volume & price of water). Impacts of different land uses on water quantity and quality in key parts / across the whole river.	Whole basin: information on the overall volume of water consumption / year, usage of water / sectors. Whole basin: loss of wetland area. Whole basin: different	Surface water (from the river): Proportion of water usage (volume / %) supplied from DRB rivers. More thorough assessment of key ecosystems involved in water retention and purification in different areas of the DRB, e.g. their different

Key ecosystem service	Rationale	Level of assessment	Data needs	Data available	Data gaps
	who provides / should maintain the service, who benefits and who ends up paying the costs of unsustainable management (e.g. due to high sediment / nutrient flow); and assessing whether the current management practises and market prices for water reflect / fact in the true value of the service.		Indication whether current water use (volume & price) is carried out on a sustainable basis.	estimates / averages re: volume / €/ ha of nutrients retained Carpathians: local assessments of water provisioning in two protected areas (e.g. local water prices and the value of water attributed to the PAs)	nutrient retention capacities. Information on costs of water purification, amount of / costs related to increased sediment load, costs of dredging etc. Ground water: Assessment of the role of ecosystems in retaining ground water in the different areas of the DRB. For illustrative case examples: volume / proportion of ground water usage at regional / local level (or "ground water dependency" in different areas).

Key ecosystem service	Rationale	Level of assessment	Data needs	Data available	Data gaps
Regulating services					
Water: purification & retention of sediments	See water provisioning above				
Natural hazard regulation: flood mitigation	Existing / restored floodplains help to mitigate flooding in the basin. Initial information and assessments exist on the estimated value of natural flood mitigation in certain areas, however a more comprehensive assessment of flood mitigation benefits and potential co-benefits from other ecosystem services would be of added value.	Regional / catchment	Information on the water retention / flood mitigation capacity of different DRB areas & ecosystems. Costs & benefits of manmade infrastructure for flood mitigation versus those of protecting / restoring ecosystems' natural capacity	Estimated average(s) of the volume of water retention / m3 of restored floodplains (Note: estimate as floodplains not yet restored) Information on the costs (EUR) of damage by previous floods	More comprehensive basin-wide assessment of the past / current / to-be-restored floodplains and their flood and other ecosystem service benefits. Costs and benefits of manmade infrastructure for flood mitigation vs. those of floodplain restoration / opportunity costs of floodplain protection.
Climate regulation: biomass (forest: old growth vs. normal forest) & soil carbon	Sustainable forestry and other land use practises, together with the protection of old growth forests, carbon-rich soils and HNV grasslands supports climate change mitigation (e.g. maintaining carbon stores and/or supporting sequestration).	Regional	Coverage of different ecosystems (e.g. forest types) and their carbon storage / sequestration. Effects of land use on carbon sequestration / storage.	Information on carbon storage (e.g. old-growth forests) in several Carpathian countries Information on carbon sequestration capacity	More specific information on impacts of future land use and their impacts on soil carbon and peat lands.

Key ecosystem service	Rationale	Level of assessment	Data needs	Data available	Data gaps
Cultural services					
Tourism & other cultural values	Sustainable tourism, recreation and broader cultural benefits related to nature / protected areas can bring significant socio-economic benefits to local communities and broader regions.	Regional Examples to showcase important local benefits	National and regional information on the tourism / visitor flow to recreational areas / parks / PAs / natural parks is needed to make a basin-wide assessment. Proportion of visitor flows and related revenues that can be attributed to biodiversity, rather than physical components of the landscape	Information on the overall tourism / visitor flow in the Danube countries. Case study examples on the volume / € value of tourism in certain protected areas (e.g. Poland and Slovakia)	Information on tourist / visitor flows linked to nature, i.e. to national parks / protected areas at regional & national level. Monetary benefits (e.g. revenue to parks and regional jobs supported) by nature related tourism at national / regional level. Data on the relationship between species and habitat properties and recreation / tourism potential.

4.3 Opportunities for new policy approaches and tools

As the sections above indicate, a number of significant gaps exist in the framework of policies that can be used to conserve and restore ecosystem services in the DRB. This section therefore outlines a number of the key conclusions regarding the potential applicability of economic instruments to support the conservation and sustainable use of ecosystems and their services in the region by filling these gaps and enhancing existing measures. A more detailed analysis can be found in Appendix 1.

Carrying out economic assessments. As highlighted above, information on the benefits of ecosystem services in the DRB is still very much based on case examples, as the quantitative information is lacking at basin / sub-basin levels. Therefore, a more comprehensive assessment(s) of the welfare benefits of ecosystem services in the DRB could help strengthen the case for ecosystem conservation and support policy-making and decision making processes. For example, highlighting the foreseen total benefits arising from sustainable fisheries, water purification, carbon sequestration and flood control could significantly increase support for the conservation and restoration of wetlands in the basin. Similarly, a more comprehensive assessment of visitor's revenues from national parks and other protected areas could help to secure adequate financing for the management of these areas.

At a more practical level, assessments of the economic benefits of ecosystem services could then better feed into the national SEA and EIA procedures. Economic assessments could also initiate the development of targeted payment schemes and incentives for the sustainable management of some key services (see below).

Developing integrated spatial plans for ecosystem services. A major constraint identified on the development of policy measures for ecosystem services is that in most countries in Europe and the BDR planning systems provide little if any control or guidance on the location of land uses, such as agriculture and forestry, other than through SEA for large-scale programmes (IEEP and Alterra, 2010). Consequently, land use is primarily driven by historic factors and short-term narrow market forces, resulting in the loss or undersupply of some ecosystem services required by society. A number of initiatives are therefore underway in some EU countries, such as the UK to assess and map ecosystem services and then use the data to inform the development of holistic visions for land use that incorporate the delivery of a wide range of ecosystem services. Such strategic visions may then be used to encourage and support the optimal use of the land by spatially targeting regulations and payments for ecosystem services to deliver the most desired land services.

Developing ecosystem service indicators and monitoring systems. As often stated in the context of the TEEB initiative, sustainable management of our natural capital (i.e. ecosystems and their services) requires measurement of its status. For example, current indicators of national welfare (e.g. Gross Domestic Product) fail to take into consideration the true consequences of ongoing ecosystem degradation and natural capital losses. Furthermore, dedicated indicators and monitoring systems have yet to be established that can provide sufficient information for us to adequately manage ecosystem services and ensure the maintenance of their underlying fundamental ecological processes. Therefore, the development of dedicated ecosystems services to complement broader environmental and biodiversity focussed indicators could help to ensure the better integration of ecosystem service considerations into policy development and every-day decision-making.

Removing incentives for the unsustainable use of ecosystems and their services. Despite the attempts to increase policy coherence (e.g. by removing environmentally harmful subsidies) a range of policy sectors still seem to contribute to the unsustainable use of ecosystems and their services. Therefore, continued efforts are needed to redirect policies and related financial support towards more sustainable practises for land and water use. For example, future support for river engineering works should be assessed against their potential impacts on ecosystem services, such as the current and future potential benefits arising from sustainable fisheries.

Similarly, agricultural practises that contribute to the degradation of the river basin (e.g. from soil erosion and the loss of soil carbon stocks) should not be further incentivised. Furthermore, a number of fees, charges and liability schemes based on the "polluter pays principle" could be put in place to incentivise the avoidance of further degradation of key ecosystem services. For example, such instruments could help to reduce soil erosion and its associated impacts on agricultural production and river water quality.

Rewarding good practises via economic incentives. One of the key insights from TEEB has been the use of different economic incentives, such as payments for environmental services (i.e. PES schemes), to support sustainable land use practises that help to maintain ecosystems' natural capacity to supply a wider range of ecosystem services, rather than those traditionally considered economically important. For example, as a result of their high biodiversity value, low agricultural management intensity and associated valued cultural landscapes, HNV farming systems support many key ecosystem services, such as those relating to water, soil carbon storage and tourism. However, they are particularly vulnerable to marginalisation, intensification and conversion to other land uses, especially in some of the new Member State DRB countries where there are associated socio-economic and infrastructure problems (such as widespread rural depopulation).

Many of the DRB countries, such as Bulgaria and Romania, have large areas of HNV farmland, and therefore long-term economic support, to improve the social and economic viability of these HNV farming systems is a high priority for the region. Indeed, PES type support is already provided for such farming systems in the EU, through agri-environment schemes and other CAP measures. However, a recent study by IEEP and Alterra (2010) concluded that it is necessary to give a higher priority in the CAP to using measures in a more integrated and effective way to ensure that existing HNV and traditional farming systems are able to counter the pressures of marginalisation, intensification and conversion to other land uses, and continue to provide high quality land services, especially biodiversity.

With regard to PES and related issues, the study recommended:

- Improving the economic viability of HNV farms (to help support the long term provision of land services) through innovation, investment and micro-enterprise support; advice and training; co-operatives; and improved market access – all specifically designed to maintain HNV farming systems (rather than support conversion to other systems).
- Encouraging Member States to use habitat and species-specific agri-environment and non-productive investment measures to support labour-intensive practices (e.g. shepherding, hand mowing) where these have biodiversity benefits, and to use forest-environment and non-productive investment measures combined with agri-environment measures to support the restoration and management of wood pastures and similar areas, for their biodiversity benefits.
- Reviewing the scope, coherence, targeting and level of CAP support (from both Pillars and all three axes of EAFRD) for HNV farming systems and management practices; and, if necessary, designing and delivering of targeted, coherent packages of CAP support that reflect the full, long term costs to farmers and the benefits to society of the ecosystem services provided (especially biodiversity); support should take into account the particular needs of small farms/parcels of high biodiversity value, the risks of marginalisation and the opportunities to add value to the outputs of HNV farming systems without losing biodiversity benefits.
- Promoting the use of Leader, local development plans and other Axis 3 measures to support HNV farming and forestry systems, involving farmers and local communities in HNV-specific support, facilitating the production of management plans for Natura 2000 and other HNV areas and providing technical support for implementation; also improving public awareness of the contribution of HNV farming systems to land services.

Other PES schemes that could be established might relate to other land use practises that store carbon (e.g. conservation of old-growth forests), maintaining floodplains for flood storage and conserving riverine and other wetland habitats for fish and reed production.

Investing in and restoring natural capital to find cost-effective solutions. Maintaining and/or restoring ecosystem services can often be much more cost effective than replacing an ecosystem's natural processes and functioning with an artificial alternative. For example, as described in Section 3.5, increasing the ability of forests and soils (e.g. old growth forests) to store and sequester carbon can be an effective and economic way of contributing to climate change mitigation. Similarly, restoring wetland habitats can be a cost-effective way of improving water quality and storage functions (EASAC, 2009). In both cases, well-managed protected areas can offer a way to maintain these ecosystem services and support biodiversity conservation objectives (TEEB, 2010).

Creating markets and business partnerships. Developing labelling schemes for sustainably produced goods (e.g. fish, sustainably produced caviar, reed for thatching or energy from biomass) can support the balanced and sustainable use of ecosystems. Similarly the development of locally branded foods and drinks can support the maintenance of traditional land use practices, which are often associated with biodiversity-rich, low input HNV farming systems. Such initiatives can thereby provide economic incentives for conserving, rather than converting, ecosystems to higher intensity systems that focus on one or a few ecosystem services at the expense of others. Indeed, with the expected increase in tourism in the DRB (described in Section 3.6) there are likely to be significant opportunities for creating businesses supplying sustainably produced / local natural products in and around key national parks and other areas of known natural beauty.

The economic approaches and instruments outlined above could be adopted and implemented on different scales in the DRB. The scope of PES schemes could range from regional to national and transnational depending on the "flow" of ecosystem services, i.e. the relationship between the ones maintaining and benefiting from the service. For example, payment schemes supporting water purification should take place at watershed / sub-watershed level whereas the maintenance of floodplain habitats for fish and reed production could be of a more regional nature. Similarly, creation of markets for new natural resources and/or ecosystem services and forging partnerships between the business sectors could take place at national, regional or even at local levels. The reform of subsidies and establishment of fees and charges on the other hand, would need to take place at a national level and/or EU level (for example with regard to reform of the CAP and the national implementation of its measures, such as the development of Rural Development Programmes). Also, as indicated in Section 4.2 above, further economic assessments and monitoring of ecosystem services would be required at national, regional or wider levels, to support the development and implementation of economic measures.

It is not suggested that the economic approaches and tools identified by TEEB and analysed in the context of this scoping study would help to solve all existing policy gaps. It is, however, suggested that such economic measures could help to address a number of current failings in the conservation of both biodiversity and broader ecosystems and their services in the DRB. It is therefore foreseen that the economic instruments outlined above would be used to support and complement, rather than replace, the existing policies and instruments for environmental protection and biodiversity conservation. As for the subsidies, it is hoped that the already ongoing reform of existing regimes would continue, with the aim of abolishing all environmentally harmful subsidies in the near future.

Finally, the economic approaches and tools for biodiversity conservation require appropriate regulatory frameworks and governance mechanisms to be in place in order to ensure that a certain level of biodiversity conservation and a minimum quality of ecosystems is maintained at all times. Other supporting measures, such as capacity building, awareness raising and targeted economic assessments, will also be needed to guarantee successful uptake of the economic tools.

5 CONCLUSIONS & RECOMMENDATIONS

5.1 Trends in the provision of ecosystem services and their socio-economic impacts

The available data on the ecosystem services assessed in detail in this study clearly show that they are of potentially significant value – even if reliable monetary estimates cannot be provided from this scoping study. Furthermore, as revealed in the key ecosystems accounts above, and summarised in Table 5.1.1, the demand for each service is increasing. At the same time, some services such as those relating to fisheries and flood mitigation are much diminished and remain threatened. Similarly, at a time when the need to protect carbon stores and boost carbon sequestration is a global and European priority, significant carbon stores are at risk from forest degradation (i.e. loss of old growth forest) and poor soil management.

Table 5.1.1 Overview of the status of & trends in key ecosystem services in the Danube Basin

ECOSYSTEM SERVICE	IMPORTANCE of the ecosystem service		QUALITY/AVAILABILITY of the ecosystem service	
	Current	**Future**	**Current trend**	**Future trend given "business as usual"**
FISHERIES	MODERATE	MODERATE/ INCREASING	↓ ↘	↓ ↘
WATER: provisioning	HIGH	INCREASING	↔	↔ ↘
WATER: purification	HIGH	HIGH	↗	↗
FLOOD PREVENTION	LOW	INCREASING	↔ ↘	↔ ↘
CLIMATE REGULATION: Forest	HIGH	INCREASING	↔	↗
CLIMATE REGULATION: soil	HIGH	INCREASING	↔	↘
TOURISM & RECREATION	MODERATE	INCREASING	↔	↗

The evident but unquantified importance of ecosystem services in the region supports the rationale for taking a precautionary approach to the conservation of ecosystem services. This is because poor decisions based on incomplete economic analyses with a short-term focus may have detrimental impacts on ecosystems and their services that are permanent or very difficult to reverse; resulting in long-term and significant economic impacts (TEEB, 2009). Such a precautionary approach should ensure that ecosystems are maintained intact, as far as possible (including all their component species), to ensure continued service provision in the face of changing environmental conditions and ecological interactions, even if there is currently insufficient supporting scientific evidence (RUBICODE summary report[19]). This approach also reduces the risk of losing potentially valuable services that have not yet been identified, and the risk of overlooking or incorrectly predicting future needs.

5.2 Policy options and economic tools for maintaining ecosystem services

This scoping study has highlighted a number of key challenges concerning the conservation of ecosystems and their services. In particular ecosystem service issues are often weak drivers in decision making because the values of ecosystem services are often unknown or underestimated, and are rarely fully captured in economic markets. Therefore, as discussed in Section 4.2, better and more comprehensive knowledge of ecosystem services is essential, as well as dissemination of their values to society to create public demand and political will for further reaching and more effective measures to conserve ecosystem services. The largely hidden values of biodiversity in particular need to be better understood by scientists, policy makers and wider society alike. But societal needs from ecosystem services are broader than those from traditional nature conservation and require the supply of provisioning, regulating and supporting services at scales and levels that are relevant for human beneficiaries. Broader, more holistic and integrated conservation strategies are therefore needed that encompass management for sustainable ecosystem services, whilst still maintaining ecosystem integrity.

The conservation of ecosystem services therefore requires more comprehensive and effective regulations to protect key ecosystem services, at least in the short-term, whilst measures to capture the values of ecosystem services in markets and other economic instruments are developed and implemented. Such measures could include, for example, the creation of commercial markets for some ecosystem services, such as carbon, the use of 'Green taxes', and the development of sustainability criteria (e.g. to inform decisions on public procurement, public support and by private consumers). Payments for ecosystem services are also increasingly being used (e.g. in the CAP) to support the provision of undersupplied public goods (Cooper *et al*, 2010) and by private companies (such as water suppliers).

The development of strategies and measures for ecosystem services does not require a revolutionary approach to conservation. As discussed in Section 4.1, most of required key policy instruments already exist and are able to conserve ecosystems, habitats and species if they are implemented more effectively and faster (Kettunen *et al*, 2010). But policy instruments need to be better integrated to encourage multi-functional land use that supports all ecosystem services rather those driven by short-term and narrow economic needs. This will require a focus on governance and institutions, and increased communication and integration across the different sectors.

[19] http://www.rubicode.net/rubicode/RUBICODE_Brochure_Final.pdf

5.3 Recommendations for further studies

This scoping study has identified a number of further research and monitoring needs (see Section 4.2 for details) that would support the development and implementation of new policy measures (see Section 4.3 and Appendix 1) that could help to conserve and restore ecosystem services. These are summarised below.

1. Carry out further scientific research to improve understanding of the interactions between ecosystem properties (including genetic diversity, species diversity, keystone species / functional groups, community structures and scale issues) and the quantity and quality of key ecosystem service provision.

2. Further investigate the effects of changes in land use and land management practices on ecosystems and ecosystem services, which in the DRB should include:
   a. intensification of HNV farmland and other agricultural systems;
   b. abandonment of farmland;
   c. floodplain land use and hydrological management;
   d. river impoundments and other engineered modifications for navigation and water storage;
   e. logging and management of forests; and
   f. afforestation programmes.

3. Carry out national assessments and more detailed local case studies that assess the monetary values of ecosystem services, including those which are not currently captured in markets (including non-use values), and assess the potential impacts of ecosystem change on these values.

4. Develop and undertake studies that quantify the opportunity costs of maintaining ecosystem services and the cost of replacing lost or degraded ecosystem services (e.g. the cost of treating water that has been polluted as a result of soil erosion, fertilizer run-off and pesticides contamination from intensive farming).

5. Increase understanding of the direct and indirect drivers of change affecting ecosystems and their services, and use modelling studies, with a range of plausible scenarios, to produce projections of future land use change (e.g. relating to agriculture, forestry, biofuels and abandonment) and demand and supply of ecosystem services, and therefore potential economic costs of ecosystem service delivery and loss.

6. Map existing and potential land uses and associated ecosystem services (e.g. with respect to afforestation, biomass crops, agricultural systems, soil protection and water/flood management), and develop indicative tools that can inform the creation of strategic and holistic visions for multifunctional sustainable land use that support ecosystem services through the Ecosystems Approach.

7. Develop more comprehensive biodiversity indicators (covering key species trends, habitat extent and habitat quality) and complementary ecosystem service indicators, and develop systematic monitoring and reporting schemes for these.

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Appendix 1. Overview of the existing policy framework (e.g. key gaps) and possible application of economic approaches and tools to support the maintenance and sustainable use of the key ecosystem services in the Danube River Basin

Key pressures causing service loss preventing sustainable use this ecosystem service	Principal influencing policy instruments	Key gap(s) and failures in the current policy framework / instrument	Relevant TEEB approaches / instruments	Suggested scale for adoption of the TEEB approach / instrument	Requirements for successful adoption & use of approach / instrument	Foreseen benefits
Fisheries (Decline in fish biodiversity & populations → decline in provisioning of fish and the livelihood of fisheries communities)						
Alteration of river's hydromorphology (e.g. construction of dams, dikes and other barriers)	National and EU regulations for assessing impacts of hydraulic constructions on ecosystems (e.g. EIA and SEA Directives) EU Liability Directive: introducing "polluter pays" principle for deterioration of ecosystem services National and EU policies supporting (e.g. financially) the removal of migration barriers (e.g. EU financing instruments) National and EU policies supporting the development of navigation / hydropower, etc. - if without due consideration of impacts to ecosystems	Regulations not targeted for conserving broader ecosystems and their services. Lack of detail / knowledge re: impacts on fish biodiversity and related fisheries ecosystems in assessing the impacts of sectoral policies. Support to the removal of migration barriers not a priority for financing (e.g. in the EU cohesion policy) Lack of policy coherence: continued degradation of ecosystems due to other sectoral policies / activities / land use practises.	Reform of subsidies: removal of harmful subsidies and actively supporting investments in removing migration barriers Developing compensation / payment schemes (PES) to support management of fish populations up-streams E.g. in the context of the EU Cohesion Policy, to support implementation of WFD and nature directives)	Subsidies: EU and national level, e.g. changes in the EU Cohesion Policy and financing and supporting these at national level implementation PES schemes: transboundary / basin level: developing compensation schemes to support management of fish populations up-streams	Back up of appropriate regulatory framework Political will and prioritisation at EU and national level. **Note: can be supported by economic assessment of fisheries benefits / cost-savings.**	Increased removal of existing migration barriers Decrease in development initiatives harmful to fisheries
Destruction of wetlands / floodplains important for reproduction and the disruption of the connection between these areas and rivers (e.g. due to agriculture and hydraulic constructions)	National and EU regulations / framework / financing for nature conservation (e.g. the Habitats and Birds Directives) Regional / national management plans and initiatives for wetland / floodplain restoration. EU Liability Directive: introducing "polluter pays" principle for deterioration of ecosystem services National and EU policies supporting increased navigation without due consideration of impacts on ecosystems (e.g. the EU TEN network), national and EU sectoral policies supporting conversion of wetlands and floodplains (e.g. agricultural and regional development policies) - if without due consideration of impacts to ecosystems	Gaps in the existence / implementation / financing of regulations re: protection Lack of resources financing conservation / restoration activities Lack of policy coherence: continued degradation of ecosystems due to other sectoral policies / activities / land use practises.	Economic assessment(s) highlighting the value of management of wetland / floodplain PAs for sustainable fisheries (without jeopardising their conservation goals) Restoring natural capital (e.g. floodplains / wetland for fisheries and restocking of fish) Reform / redirecting of subsidies to support the above Payments for ecosystem services (PES) for conservation of floodplains / wetlands and/or to	Local / regional / national / transboundary With due EU support (e.g. redirecting / prioritising of EU subsidies)	Back up of appropriate regulatory framework Political will and prioritisation at EU and national level. **Note: can be supported by economic assessment of fisheries benefits / cost-savings.** Carrying out appropriate assessments to establish the level of PES schemes. Create appropriate framework for establishment and monitoring of PES (e.g. capacity building).	Increase funding, support and incentives to conservation / restoration activities.

Key pressures causing service loss preventing sustainable use this ecosystem service	Principal influencing policy instruments	Key gap(s) and failures in the current policy framework / instrument	Relevant TEEB approaches / instruments	Suggested scale for adoption of the TEEB approach / instrument	Requirements for successful adoption & use of approach / instrument	Foreseen benefits
			encourage sustainable fishing. Supported by appropriate economic assessment of level of PES payments.		Capacity building and raising awareness	
Over-fishing of certain valuable species (e.g. sturgeon)	National regulations to prevent over-fishing (in some countries), e.g. quotas for fishing / fees for over-fishing. International regime for the conservation of sturgeon (CITES and the EU Wildlife Trade Regulation), i.e. preventing illegal trade and regulations for labelling fisheries products (i.e. caviar) to regulate origin.	Gaps in the existence & implementation of regulations preventing over-fishing Gaps in the implementation of Wildlife Trade regulations (e.g. lack of inspection effort) Lack of political & stakeholder support to conservation / restoration activities.	Improving / developing new labelling schemes for sustainably produced caviar / sturgeon Establishing private - business partnerships between fisheries of sustainable sturgeon (caviar) and private sector (e.g. restaurants and shops using / selling caviar)	Labelling schemes: regional / national / transnational level Partnerships: all possible (from local to international) depending on the identified potential	Back up of appropriate regulatory framework Identification of viable partnerships Capacity building	Better implementation of existing provisions / policies for over-fishing
Organic / nutrient / hazardous pollution	General water quality: EU Water Framework Directive (WFD) and national / regional regulations supporting the quality of water Organic pollution: EU Sewage Sludge Directive Nutrient pollution: EU Nitrates Directive, minimum requirements for limiting nutrient emissions under CAP Hazardous substances: EU Integrated Pollution Prevention Control Directive (96/61/EC), EU Liability Directive: introducing "polluter pays" principle for deterioration of ecosystem services Danube River Basin Management Plan: protection, conservation and restoration of wetlands/floodplains and the implementation of the “no net-loss principle	EU Directives' provisions only apply to EU Member States WFD implementation slow Existing instruments do not focus directly on conservation of biodiversity, ecosystems and their ecosystem services	Implementing fees / charges / liability schemes based on the "polluter pays principle" Reform / redirecting of subsidies to support the above Rewarding good practises via economic incentives: support to low-nutrient / organic agriculture → reduced nutrient pollution	National / trans-boundary within the basin / EU	Back up of appropriate regulatory framework Capacity building	Better implementation of existing provisions / policies for limiting pollution

Key pressures causing service loss preventing sustainable use this ecosystem service	Key policy existing instruments	Key gap(s) and failures in the current policy framework / instrument	Relevant TEEB approaches / instruments	Suggested scale for adoption of the TEEB approach / instrument	Requirements for successful adoption & use of approach / instrument	Foreseen benefits
Water provisioning and purification (demand for fresh water likely to slightly increase and water supplies may decline with climate change)						
Land use practises causing deterioration of ecosystems' capacity to retain and purify water	National and EU regulations / framework / financing for nature conservation (e.g. the Habitats and Birds Directives) National and EU regulations / frameworks supporting maintenance of water quality, sustainable land use practises and maintenance of the minimum quality of ecosystems (e.g. EIA & SEA, WFD, minimum requirements under CAP). EU Liability Directive: introducing "polluter pays" principle for deterioration of ecosystem services Regional / national management plans and initiatives for wetland / floodplain restoration. National and EU policies resulting in degradation of ecosystems and the conversion of wetlands and floodplains without due consideration of impacts to ecosystems' ability to retain and purify water. E.g. agricultural and regional development policies for intensive land use.	Gaps in the existence / implementation / financing of regulations re: protection Existing instruments do not focus directly on conservation of broader ecosystems and their capacity to retain & purify water (e.g. EIA & SEA) No common indicators for / monitoring of the status of the service (only water quality, i.e. "output" of the service) EU Directives' provisions only apply to EU Member States WFD and Liability Directive implementation slow Lack of policy coherence: continued degradation of ecosystems due to other sectoral policies / activities / land use practises.	<u>Economic assessment(s)</u> highlighting the value of ecosystem's water retention & purification capacity vs. required replacement costs. <u>Development of monitoring / indicators</u>: development of targeted, wide-scale and systematic monitoring of the service → to ensure maintenance <u>Implementing fees / charges / liability schemes</u> based on the "polluter pays principle" <u>Reform / redirecting of subsidies</u> to support sustainable land use practises maintaining natural water retention and purification <u>Restoring natural capital</u> (e.g. ecosystem's ability to retain and purify water) <u>Payments for ecosystem services (PES)</u> to support land use practises that maintain ecosystems' natural capacity to retain and purify water (e.g. conservation of floodplains / wetlands). Supported by appropriate economic assessment of level of PES payments.	<u>Economic assessment(s) & monitoring:</u> national / regional / basin level <u>Fees & charges</u>: national / sub-basin level <u>Subsidies</u>: EU and national level, e.g. changes in the EU Cohesion Policy and financing and supporting these at national level implementation <u>Restoring natural capital</u>: restoration of key ecosystems from local to max. sub-basin level <u>PES schemes</u>: from local to (sub)basin level to develop compensation schemes to support maintenance of important ecosystems purifying water.	Back up of appropriate regulatory framework Political will and prioritisation at EU and national level. **<u>Note</u>: can be supported by economic assessment of the value of nature.** Carrying out appropriate assessments to establish the level of PES schemes. Create appropriate framework for establishment and monitoring of PES (e.g. capacity building). Capacity building and raising awareness	Increase funding, support and incentives to conservation / restoration activities.
Increase in organic / nutrient / hazardous pollution	<u>General water quality</u>: Water Framework Directive (WFD) and national / regional regulations supporting the quality of water <u>Organic pollution</u>: EU Sewage Sludge Directive <u>Nutrient pollution</u>: EU Nitrates Directive, minimum requirements for limiting nutrient emissions under CAP <u>Hazardous substances</u>: EU Integrated Pollution Prevention Control Directive (96/61/EC)	EU Directives' provisions only apply to EU Member States Implementation of certain EU Directives, e.g. WFD and Liability Directive, slow	<u>Implementing fees / charges / liability schemes</u> based on the "polluter pays principle" <u>Rewarding good practises via economic incentives</u>: support to low-nutrient / organic agriculture → reduced nutrient pollution <u>Reform / redirecting of subsidies</u> to support the above	<u>National / trans-boundary</u> within the basin / EU	Back up of appropriate regulatory framework Capacity building	Better implementation of existing provisions / policies for limiting pollution

Key pressures causing service loss preventing sustainable use this ecosystem service	Key policy existing instruments	Key gap(s) and failures in the current policy framework / instrument	Relevant TEEB approaches / instruments	Suggested scale for adoption of the TEEB approach / instrument	Requirements for successful adoption & use of approach / instrument	Foreseen benefits
	EU Liability Directive: introducing "polluter pays" principle for deterioration of ecosystem services Danube River Basin Management Plan: protection, conservation and restoration of wetlands/floodplains and the implementation of the “no net-loss principle					
Flood mitigation (maintaining and restoring functional floodplains)						
Loss of floodplain wetlands and other habitats due to raised flood embankments and conversion to agriculture / housing and industry etc	National and EU regulations / framework / financing for nature and wetland conservation (e.g. the Habitats and Birds Directives) EU SEA and EIA Directives, and similar requirements in non-EU countries EU Floods Directive (but Flood Management Plans not required until 2015). Regional / national management plans and initiatives for wetland / floodplain restoration. National and EU policies resulting in degradation of ecosystems and the conversion of wetlands and floodplains without due consideration of impacts to other ecosystem services. E.g. agricultural and regional development policies for intensive land use.	Gaps in the existence / implementation / financing of regulations re: nature / wetland protection Poor treatment of biodiversity issues in EIA and SEA , esp regarding ecosystem service benefits EU Directives' provisions only apply to EU Member States Policy coherence: need for further consideration of the synergies between biodiversity and climate change agendas re: wetland restoration.	Economic assessment(s) highlighting the value of active floodplains in flood mitigation and a range of other ecosystem services, e.g. water purification and reed for energy from biomass Restoring natural capital Restoration floodplain function, and where feasible, semi-natural ecosystems (e.g. grassland or wetlands) and associated services Payments for ecosystem services (PES) to support flood storage benefits (e.g. supported by flood storage capacity offsets or development levy for flood plain developments), and associated ecosystem services.	Economic assessment(s): national / regional / basin level Subsidies: EU and national level, e.g. changes in the EU Cohesion Policy and financing and supporting these at national level implementation Restoring natural capital: restoration of key ecosystems from local to max. sub-basin level PES schemes: from local to (sub)basin level to develop compensation schemes to support the maintenance of overall wetland ecosystem services	Back up of appropriate regulatory framework Political will and prioritisation at EU and national level. **Note: can be supported by economic assessment of the value of nature.** Further define flood storage needs and restoration opportunities and identify optimal locations that provide multiple-ecosystem service benefits. Develop no-net-loss policy for flood storage capacity to drive requirement for offsets, or levy to fund restoration. Capacity building and raising awareness	Increased funding, support and incentives for wetland conservation / restoration activities.

Key pressures causing service loss preventing sustainable use this ecosystem service	Key policy existing instruments	Key gap(s) and failures in the current policy framework / instrument	Relevant TEEB approaches / instruments	Suggested scale for adoption of the TEEB approach / instrument	Requirements for successful adoption & use of approach / instrument	Foreseen benefits
Climate mitigation (maintenance and restoration of carbon stores, and enhancement of carbon sequestration rates)						
Degradation of forests (e.g. old growth forests) and the loss of carbon storage and carbon sequestration	National and EU regulations / framework / financing for nature and forest conservation (e.g. the Habitats and Birds Directive) Regional / national management plans and initiatives for forest restoration / afforestation Global, EU and national policies for mitigating climate change National and EU policies resulting in degradation of forest ecosystems, e.g. the conversion of (old growth) forests without due consideration of impacts to other ecosystem services. E.g. forestry, agricultural and regional development policies for intensive land use.	Gaps in the existence / implementation / financing of regulations re: nature / forest protection Regulations not targeted for conserving broader ecosystems and their services. No common indicators for / monitoring of the status of the service EU Directives' provisions only apply to EU Member States Lack of EU competence over forest issues and no common EU forest policy. Policy coherence: need for further consideration of the synergies between biodiversity and climate change agendas re: forest management.	Economic assessment(s) highlighting the value of ecosystem's in mitigating climate change vs. costs of alternative mitigation measures (e.g. the value of conserving old growth forests) Development of monitoring / indicators: development of targeted, wide-scale and systematic monitoring of the service → to ensure maintenance Reform / redirecting of subsidies to support sustainable land use practises that maintain carbon capture / storage Restoring natural capital (e.g. ecosystem's ability to retain carbon via afforestation) Payments for ecosystem services (PES) to support land use practises that maintain ecosystems' natural capacity to retain carbon. Supported by appropriate economic assessment of level of PES payments.	Economic assessment(s) & monitoring: national / regional / basin level Subsidies: EU and national level, e.g. changes in the EU Cohesion Policy and financing and supporting these at national level implementation Restoring natural capital: restoration of key ecosystems from local to max. sub-basin level PES schemes: to support carbon storage and sequestration, e.g. through carbon trading and/or private voluntary carbon offsetting.	Back up of appropriate regulatory framework Identification of viable partnerships Carrying out appropriate assessments to establish the feasibility of PES schemes for carbon. Create appropriate framework for establishment and monitoring of carbon storage and sequestration to underpin regulation of carbon trading . Capacity building	Maintenance and restoration of forest area and quality (e.g. old-growth forests) to retain carbon
Soil erosion and degradation	National and EU regulations / framework / financing for nature and soil conservation (e.g. the Habitats and Birds Directives, protection of soil quality under CAP) National and EU policies resulting in degradation of soils.	As above and also: No common EU policy for soils (i.e. Soils Directive pending)	As above and also: Implementing fees / charges / liability schemes based on the "polluter pays principle" re: soil degradation.	As above and also: Fees & charges: national / sub-basin level	As above and also: Fees & charges: established via appropriate regulatory framework	Maintenance and restoration of of soils' capacity to retain carbon and prevention of soil erosion / degradation.

Key pressures causing service loss preventing sustainable use this ecosystem service	Key policy existing instruments	Key gap(s) and failures in the current policy framework / instrument	Relevant TEEB approaches / instruments	Suggested scale for adoption of the TEEB approach / instrument	Requirements for successful adoption & use of approach / instrument	Foreseen benefits
Tourism and recreation (maintenance and growth of sustainable nature-based tourism)						
Destruction of natural ecosystems → decreased "attraction " for tourism	National and EU regulations / framework / financing protected areas, national parks and natural / cultural heritage (e.g. the Habitats and Birds Directives) National and EU regulations / frameworks supporting the quality of nature (e.g. EIA & SEA, WFD, minimum requirements under CAP). Regional / national management plans and initiatives for restoration of protected areas & natural / cultural heritage. Regional / national / EU policies promoting sustainable tourism National and EU policies resulting in degradation of protected areas and natural / cultural heritage values. E.g. agricultural and regional development policies for intensive land use.	Gaps in the existence / implementation of regulations re: protection of nature and natural / cultural heritage (e.g. EU Directives) No national level indicators for / monitoring of nature related tourism (e.g. overall visitor flows to national parks) Lack of policy coherence: continued degradation of protected and other natural areas due to other sectoral policies / activities / land use practises.	Economic assessment(s) highlighting the value of nature (e.g. protected areas) for tourism Development of monitoring / indicators: development of targeted, wide-scale and systematic monitoring of the benefits of nature related tourism Implementing fees / charges / liability schemes based on the "polluter pays principle" re: natural ecosystems. Reform / redirecting of subsidies to support sustainable land use practises Restoring natural capital (e.g. protected areas and areas of high natural / cultural value) Rewarding good practises via economic incentives: support to voluntary conservation and non-intensive land use practises etc. Payments for ecosystem services (PES) to support protected area management. Supported by appropriate economic assessment of level of PES payments.	Economic assessment(s) & monitoring: national / regional / basin level Fees & charges: national / sub-basin level Subsidies: EU and national level, e.g. changes in the EU Cohesion Policy and financing and supporting these at national level implementation Restoring natural capital: restoration of key ecosystems from local to max. sub-basin level Incentives and PES schemes: from local to (sub)basin level to develop compensation schemes to support maintenance of important ecosystems purifying water.	Back up of appropriate regulatory framework Identification of viable partnerships Carrying out appropriate assessments to establish the level of PES schemes. Create appropriate framework for establishment and monitoring of PES (e.g. capacity building). Capacity building	Increased support to protected areas and conservation of natural / cultural heritage

Key pressures causing service loss preventing sustainable use this ecosystem service	Key policy existing instruments	Key gap(s) and failures in the current policy framework / instrument	Relevant TEEB approaches / instruments	Suggested scale for adoption of the TEEB approach / instrument	Requirements for successful adoption & use of approach / instrument	Foreseen benefits
	Lack of baseline funding for protected areas, national parks etc. → failure to meet conservation objectives and also the lack of resources to promote sustainable tourism and create extra revenue.	National and EU financing for protected areas, national parks and natural / cultural heritage National and EU policies with competitive / contradicting interest re: public funding.	Lack of sufficient funding for protected areas / Natura 2000 / biodiversity conservation.	Economic assessment(s) highlighting the value of nature (e.g. protected areas) for tourism → increasing attractiveness for investment Improving / developing new labelling schemes for sustainably produced products from protected areas Establishing private - business partnerships to support both the management and sustainable use of protected areas (e.g. tourism) Payments for ecosystem services (PES) to support protected etc. area management. Supported by appropriate economic assessment of level of PES payments.	See above and also: Labelling schemes: regional / national / transnational level Partnerships: all possible (from local to international) depending on the identified potential	See above