Final report study on the Economic value of groundwater and biodiversity in European forests

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by

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Executive summary

National and international attention for the vulnerability of water systems is increasing, as in more and more regions across the globe, drought conditions have been exacerbated if not created by increased population density and land development, which, in turn, may have been made even worse by global warming, resulting in record-setting droughts.

From a European perspective, over the past thirty years, droughts have dramatically increased in number and intensity in the EU. Recent trends show a significant extension of water scarcity across Europe. In a context where changes in climate are foreseen, this trend is expected to continue and even worsen and the EU states that a number of challenges have to be addressed: full implementation of the Water Framework Directive (WFD), ineffective water pricing policies in EU member states, water saving strategies and initiatives, integration of water-related concerns into water-related sectoral policies, as well as collecting information and creating knowledge.

Ecosystems provide a wealth of services that are fundamental for proper environmental functioning and economic and social development. While the demand for these services, including provision of clean freshwater is continually increasing, the capacity of ecosystems to provide such services is hampered by their ever-growing degradation.

The availability and quality of water in many regions of the world are more and more threatened by overuse, misuse and pollution and it is increasingly recognised that this is strongly influenced by forests. Forests can protect drinking water supplies. Managed forests usually have lower input of nutrients, pesticides and other chemicals than more intensive land uses such as agriculture. Forests can also protect soils and reduce erosion rates.

Most ecosystem services are not traded on markets and do not have a price, but this does not mean they have no economic value. In recent years, innovative financing mechanisms, and especially payments for ecosystems services (PES) have been recognised as crucial for addressing some of the failures in environmental management.

This report aims to give an insight in the economic value of groundwater and biodiversity in European forests. It will explore the current state of the art of PES in EU member states in relation to forests and groundwater, by looking at the following objectives:

- To analyse the different ownership structures of groundwater sources and the financial benefits for the use of this natural resource that currently exist in forest areas in Europe;
- To develop a case for integrating the economic value of groundwater and the ecosystem services provided by European forests into EU policy instruments;
- To develop knowledge on the opportunities for nature conservation and more specifically sustainable forest management in relation to the economic value of groundwater resources.

Economic development that destroys biodiversity and impairs services can create costs to humanity in the long run that can greatly exceed the short-term economic benefits of the development. These costs are generally hidden from traditional economic accounting, but are nonetheless real and are usually borne by society at large. Tragically, a short-term focus in land-use decisions often sets in motion potentially great costs to be borne by future generations. This suggests a need for policies that achieve a balance between sustaining ecosystem services and pursuing the worthy short-term goals of economic development.

The prices charged to consumers for water consumption are typically not reliable measures of the value of the water to consumers, as they are often set administratively, with no regard for supply and demand. This can be misleading, as the ecosystem services essential for providing drinking water can often not be protected on the basis of the price paid for it. Payments for ecosystem services is a new financing mechanism that rewards stakeholders who conserve natural resources by providing payments for valuable goods and services resulting from their conservation activities.

The PES approach is attractive for a number of reasons, as it:

- generates new financing, which would not otherwise be available for conservation;
- is likely to be sustainable, as it depends on the mutual self-interest of service users and providers and not on the whims of government or donor funding; and
- is likely to be efficient, as it conserves services of which the benefits exceed the cost of providing them, and does not conserve services when the opposite is true.

Three types of PES exist: self-organized private agreements that are negotiated business-to-business or business-to-community; public payment schemes through which public agencies purchase services; and trading schemes, in which industries can trade credits below an established cap.

In this report, the state of development of forest-groundwater related PES schemes in the EU has been explored. It is demonstrated that PES structures exist in EU member states which fund afforestation and sustainable forest management practices and thus support, maintain or even develop the protective functions of forests with regards to groundwater. The case studies in Denmark, Germany, Spain and Austria, show that PES schemes can comprise diverse structures which have to be distinguished. They can range from voluntary compensation to non-voluntary compensation schemes for forest maintenance, afforestation, reforestation and sometimes agro-environmental activities.

The report shows that forest-groundwater PES schemes are not yet in place in most countries of the EU. However, the case studies prove that PES can be a valuable instrument for increasing the interest of land and forest owners in developing these forest functions, because if designed and implemented well, PES offer great potential for protecting ecosystems. The future development of such mechanisms in other countries can benefit from the experiences of the existing examples.

The report further indicates that the WFD as well as the legislation of several EU member states have the potential to promote the development of future forest-groundwater PES in more EU member states. While the forest and groundwater related legal frameworks differ considerably from member state to member state, it is possible to find a clear answer to each of the following questions:

Who has a right to and therefore can be paid for the ecosystem services which are provided?

- The owners of forests which provide groundwater related ecosystem services can become sellers in forest-groundwater PES schemes. Forests in EU member states are either owned by private or public entities.

Who has to pay for the benefits received from the provided ecosystem services?

- In all EU member states, usually all groundwater users (private households, industries, and the agricultural sector) are obliged to pay for the utilization of groundwater resources. Such payments are sometimes dedicated to environmental purposes.

Who facilitates the development and implementation of PES agreements between the different parties involved (providers and beneficiaries)?

- The entity which collects the payments made for the provision of groundwater resources has the potential to become an intermediary who facilitates the development and implementation of PES schemes by linking the charges paid by the water users to providers of groundwater related forest ecosystem services.

The frameworks of some member states show a need for consolidation which would make the actual implementation of especially groundwater related legislation much easier. Such efforts are ongoing in a number of countries, but not yet all.

In this context, the WFD can be a trigger for member states to include PES schemes for the conservation of groundwater related forest ecosystem services in their groundwater policies and legislation. The obligation to develop river management plans supports an integrated water resources management approach and provides an opportunity to build the case for forest-groundwater PES. Also, the required economic analysis and the concept of full cost recovery could influence the decision-making in favour of the establishment of forest-groundwater PES.

However, in order to tap the full potential of the WFD for the development of such PES schemes, it has to be clarified that:

- Forest ecosystem services should be used for the achievement of environmental objectives and therefore need to be considered by the economic analysis and in river basin management decisions, and
- Forest ecosystem services are "water services" as defined in Article 2 (38) WFD and therefore part of the principle of full cost recovery.

Currently, the protective functions of forests are seldom leading to any income generation for forest owners. In addition to countries' groundwater compensation structures, a variety of EU funds and financial instruments address environmental and social dimensions of sustainable forest management and environment in general. Those funds might provide additional financial resources to develop and implement forest-groundwater PES schemes. In this report, a number of key aspects have been highlighted to define the scope of PES schemes related to forests and groundwater in Europe:

- In the forest as well as groundwater related legislation of EU member states, different legal instruments can be identified which directly oblige forest owners to take protection measures for groundwater resources. Apart from the possibility of designating groundwater protection areas which prohibit certain forest uses, other groundwater related obligations of forest owners exist. Since groundwater bodies are generally considered important resources for drinking water supply, the public interest in their protection often prevails over the vested property rights. As a consequence, regardless of public or private forest ownership, as well as the country's legal approach to groundwater ownership (public ownership, public-private ownership, and res nullius), forest management has to take possible impacts on groundwater resources into account.

- The groundwater compensation structures in EU member states show clear possibilities for introducing payments for environmental services. Eco-taxes are already used in a number of countries to collect funds for environmental protection measures. Green fees can also be charged to groundwater users.

- Restoration and maintenance of forest ecosystems is not only a high priority for the strengthening of Natura 2000 and biodiversity protection, but also for the protection of drinking water resources. In Natura 2000 sites, the economic function of forests, usually the highest priority in forest management, will have to be adapted according to the requirements of the ecological function and the conservation of biodiversity, which calls for changes in current forest management practices.

- Small scale PES projects can qualify as LIFE+ projects which help to develop PES experiences that benefit policy-making afterwards.

- The pricing of water needs to internalize the additional management costs of forests, which are incurred to cater for the needs of water protection. The segment of the water price, which covers these additional management costs has to be paid to the resource manager or owner. In addition, it is important that water suppliers have the right to pass on environmental costs in the water price to their customers.

- Prevention of pollution is more cost effective than reducing it once groundwater has already reached high levels of pollution. Costs of cleaning polluted water are clearly higher than establishing management practices for forests and water areas that prevent the deterioration of water quality. Therefore, having a system to pay for pollution, as suggested by the Water Framework Directive, according to its "Polluter Pays Principle", should be replaced by a system that provides incentives for the prevention of pollution. In general, incentives are a better tool than payments for obtaining commitment of water users and providers.

- Considering water protection forests as "natural infrastructure" is vitally important to maintain the production of, inter alia, the ecosystem service of providing drinking water in required quantity and quality. Restoration and maintenance of the natural ecosystems can contribute to reducing the costs of providing clean drinking water, now and in the future.

- To protect watershed areas and to enhance the water quality to achieve a good ecological status, a strong link can be made between the Water Framework Directive and LIFE+, as the LIFE+ offers funding opportunities to invest in improvement of environmental protection.

Various EU policy and instruments have to be combined to create complementary and cross-cutting methods for establishing payment for ecosystem services in relation to groundwater and forests.

There are two complementary types of PES schemes, which are: 1) investments, such as the transformation of forests and reforestation and 2) those that are related to maintenance and management of the existing ecosystems.

Under the current EU regulations, integration of environmental priorities in their spending programmes is not an obligation for individual member states. Therefore it is highly important that efforts are made to raise awareness with all parties involved, for the opportunities of PES schemes at a member state level. Rather than creating legal rights and obligations for compensation of forest owners for delivering the service of clean water, one should be offering voluntary schemes of incentives. EU Member States should be encouraged to follow this advice, taking into account that there are major differences among member states with regards to groundwater ownership, internalization of management costs of water protection forests into water pricing and the sharing of income generated by water use.

To conclude the analysis of opportunities for the development of PES based on existing EU policy and funding instruments leads to three options:

1. Use existing policies and regulations to introduce PES schemes.

2. Introduce changes to existing policies and regulations, to be adopted by Council, in order to better reflect the opportunities for PES with cross-linking the different policy areas. This also includes reviews of existing regulations, such as the CAP Health check.

3. Design a comprehensive scheme or new Directive for PES.

1 Introduction

National and international attention for the vulnerability of water systems is increasing, as in more and more regions across the globe, drought conditions have been exacerbated if not created by increased population density and land development, which, in turn, may have been made even worse by global warming, resulting in record-setting droughts. One recent report on the human impact on oceans found that we are now using much more water than can be replenished. Global water consumption is doubling every 20 years and in many places supplies are running short as rising consumption cannot be matched by fresh rainfall and many underground aquifers are drying up[1].

Water has replaced climate change on the agenda of the 2008 World Economic Forum in Davos, as the UN Secretary General told that water is the common denominator between disease, rising food prices and crises in conflict areas, such as Darfur. Industry has an important role to play in minimising the impact of water use of its own operations and increasingly examples show their commitment to this. Both Coca-Cola and PepsiCo have net zero water usage as a goal.

Public water utilities are planning on how to restructure water rates to better reflect true costs without causing public harm. In the meantime, the price of water is increasing; according to a recent study, municipal water has increased by more than 25 percent in price in the United States in the last five years and by more than 10 percent in Australia in just one year.

With these developments, it is expected that water companies will search for innovations to add value and to seek for the most effective means to supply and protect water, as well as seeing it as a new market opportunity.

Another question is how to fairly price water, as in Spain, for example, farmers pay a price for water that is only about 2 percent of its real cost. Rice and wheat farmers in California's central valley use one fifth of the state's water but the low prices they pay represent a yearly subsidy estimated at $ 416 million for 2006[2], thereby jeopardising the groundwater tables. At the same time, slum-dwellers in Dar es Salaam pay the equivalent of $ 8 for 1000 liters of water.

From a European perspective, over the past thirty years, droughts have dramatically increased in number and intensity in the EU[3]. The number of areas and people affected by droughts went up by almost 20% between 1976 and 2006. Recent trends show a significant extension of water scarcity across Europe. In a context where changes in climate are foreseen, this trend is expected to continue and even worsen and the EU states that a number of challenges have to be addressed: progressing towards full implementation of the Water Framework Directive (WFD), ineffective water pricing policies, water saving, integration of water-related concerns into water-related sectoral policies and knowledge and information.

This shows a combination of elements which have to be taken into account for addressing water scarcity and droughts: making use of policies, as well as economic instruments. This brings us to the core of this study, ensuring that water transfers do not hurt rural communities or the environment and determining the scope for water-related payments for ecosystem services (PES).

1.1 Understanding the value of ecosystem services and biodiversity

What services can be provided?

Ecosystems provide society with a wide range of services on which people, companies, and societies rely. Ecosystem services can be divided in four categories[4]:

[1] Economist, July 2008, Water – A soluble problem, more trading could help to alleviate water shortages
[2] Financial times, Fiona Harvey, A costly thirst, April 3rd 2008
[3] Communication from the Commission to the European Parliament and the Council, Addressing the challenge of water scarcity and droughts in the European Union, Brussels 17.07.2007, COM (2007) 414 final
[4] Stefano Pagiola, Konrad von Ritter, Joshua Bishop (2004): Assessing the Economic Value of Ecosystem Conservation, The World Bank Environment Department in collaboration with The Nature Conservancy and IUCN—The World Conservation Union

- Provisioning services,
- Regulating services,
- Supporting services, and
- Cultural services.

Valuable commodities that natural ecosystems provide are, for example, freshwater, plants and animals as sources of food or medicinal products, or wood and fiber as basic materials for construction or clothing. Aesthetic or cultural benefits provided by natural ecosystems, include, for example, beautiful views and recreational or educational opportunities. Human economies also depend upon natural ecosystems for a range of biological and chemical (regulating and supporting) processes. Examples of these ecosystem services include the purification of air and water, regulation of rainwater run-off and drought, control of pests and diseases, waste assimilation and detoxification, soil formation and maintenance, plant pollination, seed dispersal and nutrient cycling, maintaining biodiversity for agriculture, pharmaceutical research and development and other industrial processes, protection from harmful ultraviolet radiation, climate stabilization (e.g., though carbon sequestration) and moderating extremes of temperature, wind, and waves.

Table 1: Ecosystems and their services[5]

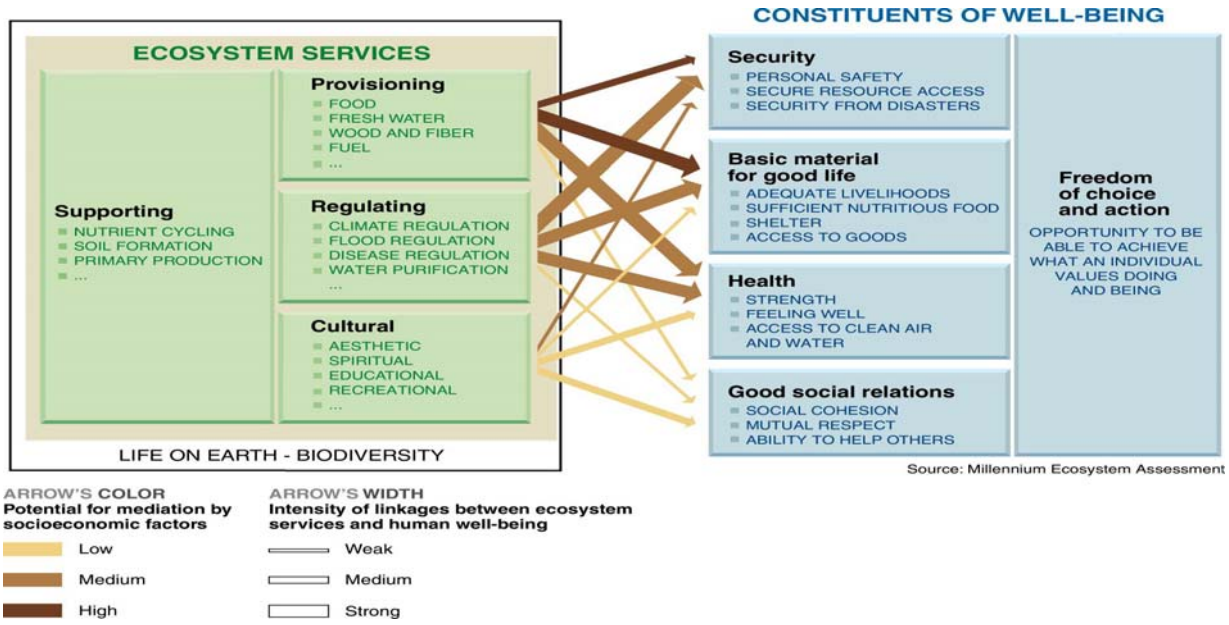
	Forests	Oceans	Cultivated/ Agricultural Lands
Provisioning Services	• Food • Freshwater • Fuel • Fiber	• Food	• Food • Fuel • Fiber
Regulating Services	• Climate regulation • Flood regulation • Disease regulation • Water purification	• Climate regulation • Disease regulation	• Climate regulation • Water purification
Supporting Services	• Nutrient cycling • Soil formation	• Nutrient cycling • Primary production	• Nutrient cycling • Soil formation
Cultural Services	• Aesthetic • Spiritual • Educational • Recreational	• Aesthetic • Spiritual • Educational • Recreational	• Aesthetic • Spiritual

Who benefits?

Humans depend on the "free" services provided by ecosystems. Ecosystem services supplied annually are considered to be worth a lot. The table below shows the interrelation between the provision of ecosystem services and their benefits for human well-being.

[5] Millennium Ecosystem Assessment (2005): Ecosystems and Human Well-being: Synthesis.

Figure 1: Interrelation between ecosystem services and human well-being[6]



As a consequence, economic development that destroys habitats and impairs services can create costs to humanity in the long run that can greatly exceed the short-term economic benefits of the development. These costs are generally hidden from traditional economic accounting, but are nonetheless real and are usually borne by society at large. Tragically, a short-term focus in land-use decisions often sets in motion potentially great costs to be borne by future generations. This suggests a need for policies that achieve a balance between sustaining ecosystem services and pursuing the worthy short-term goals of economic development.

Who provides them?

The services are provided by the owner or manager of a particular ecosystem. Suppliers can therefore be, for example, land or forest owners, tenants, etc.. However, the alleged supplier of a service must be able to verify the existence and delivery of the service that shall be charge for. In order to do this, it is important to

- Define a service,
- Assess if the service can be provided by a particular ecosystem, and
- Measure if the service is actually delivered.

For the latter, it is essential to establish a baseline against which additional units "produced" can be measured.

How much are they worth to users?

Knowing that ecosystem services are valuable is of little use if it does not lead to real investments in conserving the natural ecosystems that provide them. Economic valuation of ecosystem services is an important instrument in this regard. It can help to identify the beneficiaries of ecosystem conservation, as well as the magnitude of the benefits they receive, and thus help in the design of mechanisms which capture some of these benefits and make them available for conservation.

Economists typically classify ecosystem goods and services according to how they are used. The main framework used is the Total Economic Value (TEV) approach. This includes:

[6] Millennium Ecosystem Assessment (2005): Ecosystems and Human Well-being: Synthesis.

- **Direct use values which** refer to ecosystem goods and services that are used directly by human beings. They include the value of *consumptive uses* such as harvesting of food products, timber for fuel or construction, and medicinal products and hunting of animals for consumption; and the value of *non-consumptive uses* such as the enjoyment of recreational and cultural activities that do not require harvesting of products.

- **Indirect use values which** are derived from ecosystem services that provide benefits outside the ecosystem itself. Examples include the natural water filtration function of wetlands, which often benefits people far downstream, the storm protection function of coastal mangrove forests, which benefits coastal properties and infrastructure, and carbon sequestration, which benefits the entire global community by abating climate change. These functions often affect activities that have directly measurable values, allowing their value to be estimated.

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

- **Non-use values which** refer to the enjoyment people may experience simply by knowing that a resource exists even if they never expect to use that resource directly themselves.

How to charge costs of ecosystem services?

Economic valuation can help to demonstrate the benefits that ecosystems generate, and the increased financial benefits (or avoided losses) that conserving these ecosystems can bring to stakeholders. However, it does not provide an answer to the question what approaches can be taken that might secure funding for ecosystem conservation and make conservation financially sustainable.

Payments for ecosystem services can contribute to the establishment of a necessary market force to correct an existing imbalance which harms biodiversity and blocks sustainable development[7]. New markets are already forming which support and reward biodiversity and ecosystem services. Mechanisms and financial products have been developed to deal with environmental liabilities. Habitat and species banks are among the most innovative new instruments, providing tradable credits.

There are three types of markets through which ecosystem services can be traded[8]:

- Self-organized private deals that are negotiated business-to-business or business-to-community;
- Public payment mechanisms through which public agencies purchase services; and
- Trading schemes, in which industries can trade credits below an established cap.

1.2 The link between groundwater and forests

To indicate the importance of groundwater, more than 97% of the free freshwater of the earth is located in the subsurface, lakes and rivers representing less than 2%.[9]

Groundwater serves as the largest freshwater reserve on earth and is mainly used by humans as potable water, as well as for agricultural and industrial purposes.[10] The enormous amount of disturbing factors in the environment,

[7] The European Communities (2008): The Economics of Ecosystems and Biodiversity – An Interim Report.
[8] Alicia Robbins (2005): Ecosystem Services Markets, Center for Sustainable Forestry at Pack Forest College of Forest Resources University of Washington.
9 D.L. Danielopol, C. Griebler , A. Gunatilaka, J. Notenboom (2001): Present state and future prospects for groundwater ecosystems.
[10] F. Mösslacher, C. Griebler, J. Notenboom (2001): Biomonitoring of groundwater systems: methods, applications and possible indicators among the groundwater biota. In “Groundwater ecology. a tool for management of water

which increase permanently, threaten more and more the quality of groundwater and the natural function and structure of groundwater ecosystems.

The availability and quality of water in many regions of the world are more and more threatened by overuse, misuse and pollution and it is increasingly recognised that both are strongly influenced by forests.[11] Forests can protect drinking water supplies. Managed forests usually have lower input of nutrients, pesticides and other chemicals than more intensive land uses such as agriculture. Forests can also protect soils and reduce erosion rates.

According to the latest IPCC report on the impact of climate change on water resources, forests are key determinants of water supply, quality and quantity, in both developing and developed countries. The importance of forests as watersheds may increase substantially in the next few decades, as freshwater resources become increasingly scarce, particularly in developing countries.

According to the European Environment Agency:

- 20% of all surface water in the EU is seriously threatened with pollution;
- 60% of European cities overexploit their groundwater resources, which supply around 65% of all drinking water in Europe;
- 50% of wetlands have "endangered status" due to groundwater overexploitation.

The prices charged to consumers for water consumption are typically not reliable measures of the value of the water to consumers, as they are often set administratively, with no regard for supply and demand.[12] This can be misleading, as the ecosystem services essential for providing drinking water can often not be protected on the basis of the price paid for it. Payments for ecosystem services is a new financing mechanism that rewards stakeholders who conserve natural resources by providing payment for valuable goods and services resulting from their conservation activities.

1.3 Payments for ecosystem services

As stated in the Communication from the European Commission to the Parliament and the Council in July 2007, in addressing water scarcity and drought, the European Commission actively promotes the use of market-based instruments in an environmental context, but they have not been widely used by member states thus far. The Water Framework Directive states that the 'user pays principle' needs to become the rule, regardless of where the water comes from, but private households should, irrespective of their available financial resources, have access to adequate water provision. Ecosystems are essential in providing the water on which we depend. It is therefore just as important to invest in the preservation of natural ecosystems as in water infrastructure.

Water is no longer free to use and time has come to find new solutions to secure this important natural resource for future generations. A variety of means will be needed in order to cover all costs: general taxes, fines, new environmental taxes, direct water resource taxes and pricing of collective services. All users of the resource must pay the cost for the services provided.

It is necessary to estimate the value of natural ecosystems as fundamental elements of the water resource. To support this approach, financing arrangements will need to be set up to allow investment and to enable them to be considered as a part of the gross domestic product to measure their economic value.

Payments for ecosystem services are schemes that try to quantify the economic value of services an ecosystem provides and either entice or mandate those who benefit from the service to pay those who maintain them. In most parts of the world, forest environmental services such as watershed protection, carbon sequestration and

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resources" (Griebler, C., Danielopol, D.L., Gibert, J., Nachtnebel, H.-P. & Notenboom, J., eds.). Official Publication of the European Communities, 173-182.

[11] I.R. Calder (2007): Forests and water – ensuring forest benefits outweigh water costs. *Forest Ecology and Management, 251*, 110–120.

[12] UNECE Water Convention Secretariat(2006).

biodiversity conservation cannot be bought and sold and markets fail to ensure adequate supply[13]. There are several reasons markets fail to emerge. One of the most important is that many environmental services provided by forests fall into the category of positive externalities or public goods. A positive externality is any uncompensated benefit. Positive externalities associated with forest protection include, for example, erosion control, reduced risk of flooding downstream and water quality maintenance. Markets typically fail to compensate those who produce positive externalities due to the absence of property rights or other legal means to require payments for the services rendered. Forest ecosystem services can also be characterised as public goods. These are a special class of externalities distinguished by their *non-excludability* and *non-rivalry*. Non-excludability means that consumers cannot be prevented from enjoying the good or service in question, even if they do not pay for the privilege.

The PES approach is a market-based approach to conservation financing based on the twin principles that those who benefit from environmental services (such as users of clean water) should pay for them, and that those who contribute to generating these services should be compensated for providing them.[14] The approach seeks to create mechanisms to arrange for transactions between service users and service providers that are in both parties' interests, thus internalizing what would otherwise be an externality. The PES approach is attractive in that it

(i) generates new financing, which would not otherwise be available for conservation;
(ii) is likely to be sustainable, as it depends on the mutual self-interest of service users and providers and not on the whims of government or donor funding; and
(iii) is likely to be efficient, in that it conserves services whose benefits exceed the cost of providing them, and does not conserve services when the opposite is true.

As mentioned before, three types of PES exist: self-organized private agreements that are negotiated business-to-business or business-to-community; public payment mechanisms through which public agencies purchase services; and trading schemes, in which industries can trade credits below an established cap.

An example of payments for ecosystem services in Europe is Vittel in France, which bought sensitive habitats and signed long-term conservation contracts with farmers whose corn and cows had polluted downstream waters in order to manage animal waste, graze dairy cows in the old-fashioned way and to reforest sensitive filtration zones.

Other compensation mechanisms for water related services are: mitigation banking, water caps, leasing and tradable permits. Mitigation banks are essentially wetlands that have been pro-actively established, enhanced, restored or preserved with the goal of generating credits that can be sold later as off-sets, comparable to carbon emission trading. Only in Australia, water is turned into a commodity that is almost as easily traded as electricity is in other parts of the world[15]. Capping of resource extraction volumes is an accepted way to manage overexploitation of surface waters and groundwaters. Around Australia, some 50 per cent of surface water management areas and 75 per cent of groundwater management units have some form of cap operating. Water resource caps can be defined as an 'upper limit for the volume of water available for use from a waterway, catchment, basin or aquifer'. Capping of water use is a primary management measure that is used to promote the sustainable use of water and prevent over allocation of the resource.

If designed and implemented well, PES offer great potential for protecting ecosystems. Wetland and conservation banking has developed in the USA to help compensate for environmental impacts by providing credits for areas of wetland or habitat created or restored elsewhere, and is now widely accepted as the most effective option in meeting offsetting legislation in this arena[16]. Water quality trading has developed in the US, providing an innovative approach to meeting requirements under the Clean Water Act, and is an approach that has been largely overlooked in Europe so far.

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[13] Natasha Landell-Mills and Ina T. Porras (2002): A global review of marketsfor forest environmental services and their impact on the poor - A research report prepared by the International Institute for Environment and Development (IIED), London.
[14] N. Robertson, S. Wunder (2005): Fresh Tracks in the Forest: Assessing incipient payments for environmental services in initiatives in Bolivia.
[15] The Katoomba group's ecosystem marketplace, www,ecosystemmarketplace.com, July 2008.
[16] Gregory Valatin and Jenna Coull (2008): Payments for Ecosystems Services, Findings and Perceptions from the USA Report.

Often the water market is compared to the booming carbon market, where the transaction is voluntary and not just based on the mandatory Kyoto Protocol. Voluntary water transactions are rarely served up with a single entity clearly willing to pay for reductions in polluting emissions.

The focus of this study will be on direct PES (self-organized agreements as well as public payments), because as clarified in the previous paragraph, the development of other mechanisms, such as groundwater related trading schemes, is not yet established in the EU.[17]

As shown above, currently, the awareness of the value and importance of biodiversity and more specifically its ecosystem services is growing in Europe. The management of water resources requires a balance of technology, legal and institutional frameworks and a market-approach which can strengthen the sharing of benefits of water related ecosystem services when coordinated effectively between different stakeholders.

This report aims to give an insight in the economic value of groundwater and biodiversity in European forests. It will explore the current state of the art of PES in EU member states in relation to forests and groundwater, by looking at the following objectives:

- To analyse the different ownership structures of groundwater sources and the financial benefits for the use of this natural resource that currently exist in forest areas in Europe;
- To develop a case for integrating the economic value of groundwater and the ecosystem services provided by European forests into EU policy instruments;
- To develop knowledge on the opportunities for nature conservation and more specifically sustainable forest management in relation to the economic value of groundwater resources.

Chapter 2 will focus on the existing legal frameworks for groundwater as well as forests in different European countries. Chapter 3 will provide insights in the methodology for collecting information on groundwater and forest related PES schemes in EU member states, with a detailed description of case studies in Denmark, Germany, Spain and Austria. Chapter 4 gives insight in options for management practices influencing water quantity and quality based on PES and the final chapter will describe the scope for developing a mechanism for creating PES in relation to groundwater and forests in the EU, focusing on existing EU policy and funding instruments.

2 Legal analysis

2.1 Objective and scope of the analysis

The objective of this section is to describe the existing legal frameworks for groundwater as well as forests in different EU member states. It is therefore intended to give a clearer picture whether these legal frameworks provide an enabling environment for PES schemes in which forest owners are compensated by those who own or use groundwater resources and benefit from quality or quantity improvements through the maintenance, sustainable management of existing, or even planting of new forests (which provide the beneficial environmental services). Information about the legal frameworks in EU member states is collected because without an understanding of them, a payment scheme cannot be developed successfully on the national level. If the development of groundwater-forest PES schemes is to be facilitated by EU policy instruments, the existing legal frameworks at the EU and member state level need to be taken into account.

Since any PES scheme is based on an agreement between at least two parties, it is first of all crucial that a reliable contract law is in place in the country where the PES is planned and implemented. It is assumed that this requirement is already fulfilled in all EU member states so that the issue of contract law will not be considered within this study.

Aside from contract law, for a functioning scheme to be developed, tenure issues and property rights regarding the natural resources and ecosystem services which the PES will be based upon need to be clear. Ownership or special use rights of the natural resources are a prerequisite when contracting for the provision of ecosystem

[17] It is also important to note that the service contract of the European Commission for this study specifically asked for a mechanism focusing on the creation of market value for the ecosystem function of groundwater in the EU.

services. Tenure issues are critical as it may not be possible to implement a PES scheme if tenure is unclear. Also, the rights over the resources can take the form of common property rights, with implications for the implementation of PES. Answers need to be given to the following questions: who has a right to and therefore can be paid for the ecosystem services which are provided; who has to pay for the benefits received from the provided ecosystem services; and also who facilitates the development and implementation of PES agreements between the different parties involved (providers and beneficiaries)?

It should be recognized that despite the importance of groundwater resources for public water supply, the legislation related to groundwater ownership, use rights, as well as compensation structure remains a field which is marginally researched and covered by the legal literature. No comparative analyses of groundwater legislation in EU member states were found which shows that a closer look at these issues had to be taken in this study.

Furthermore, the development of any PES scheme has to be seen as operating within a wider framework of institutions. This framework comprises the policies, rules and administrative agencies that govern forest and groundwater relations. By specifying the rights and obligations of owners and users of groundwater as well as forest resources, the institutional framework sets the rules in which a PES scheme can be implemented. Furthermore, it defines the responsibilities and powers of those bodies that are in charge of groundwater and forest management, and the structure and conditions of related compensation mechanisms.

An analysis of existing compensation mechanisms for the use of groundwater is especially important, since the collected money provides a potential source of funds through which PES schemes can be financed. High investments - with returns occurring only later in the future - are frequently needed in order to satisfy the requirements of the scheme. The financial resources for such investments may however be lacking which means that the possible, sometimes temporary, economic loss resulting from the adoption of changes in management practices or land uses required by the scheme cannot be compensated.

Section 2.2 and section 2.3 below shall give a short overview and analysis of the following issues related to groundwater as well as forests:

Groundwater (section 2.2)

- The institutional framework related to groundwater resources comprising information on the main groundwater legislation as well responsible authorities;
- The ownership structure, as well as the use rights regarding groundwater resources; and;
- The compensation structure related to groundwater use.

Forest (section 2.3)

- The institutional framework related to forests comprising information on the main forest legislation as well as responsible authorities;
- The ownership structure of forest land and resources, and possible rights and duties of forest owners regarding groundwater resources.

This overview and analysis will then provide the basis for selecting 6 member states for which the above listed issues will be explained in more detail in the annex 4.

Section 2.4. will draw a conclusion.

In order to carry out this task, a desk-study of groundwater as well as forest legislation was undertaken. This desk-study required first the collection and secondly the review of a variety of legal documents. Given the difficulty of accessing the needed legal documents of all EU member states, such a desk-study is a challenge. No public data base yet exists which would comprise all relevant documents in their latest version.[18] Furthermore, for some countries, the relevant legal documents only exist in their national language.

[18] Even ECOLEX, a joint initiative by the United Nations Environmental Programme (UNEP), the Food and Agricultural Organization (FAO) and the International Union for the Conservation of Nature (IUCN) which is widely considered as the most comprehensive, publicly available database in the area of environmental law, does not provide all relevant documents for all EU member states in their latest version.

Under these circumstances, it is important to note that this legal study does not claim to be complete, and is not meant to give an exhaustive picture of the full spectrum of groundwater and forest legislation in all EU member states. 20 EU member states could be covered in this review; however, only to a differing level of detail.[19]

Finally, it has to be understood that the scope of the reviewed legislation had to be limited to the most important legal documents. This limited scope was necessary, since a country's full legal framework for groundwater as well as forest does not only consist of national water and forest laws. Instead, these laws also may require more specific regulations at the national to local level which regulate and ensure their actual implementation. Also, not only laws and regulations directly related to groundwater or forest play a key role in the set up of the legal frameworks, but also indirectly related legislation, such as soil legislation, agricultural legislation, planning legislation, etc. (to name a few). In order to provide a complete picture, such indirectly related legislation would also need to be taken into consideration which, however, exceeds the feasibility of this study.

2.2 Overview of legal frameworks related to groundwater at the EU and member states level

2.2.1 Institutional framework

EU level

In order to better understand the EU member states' institutional frameworks related to groundwater, it must be recalled that such national frameworks are highly influenced and guided by EU legislation. The European Union regulatory groundwater framework dates back to the end of the 1970s when Directive 80/68/EEC on the protection of groundwater against pollution caused by certain dangerous substances was adopted. This Directive aimed at preventing the direct or indirect introduction of high-priority pollutants and limiting the introduction of other pollutants in order to avoid groundwater pollution by these substances. In the following two decades, major assessments of groundwater resources in EU member states led authorities to consider the need for further action to avoid long-term deterioration of the groundwater quality and quantity.

In the meantime, the Water Framework Directive (WFD, Directive 2000/60/EC) has been adopted which provides the framework for groundwater protection at the EU level. In summary, the WFD requires that all groundwaters within defined river basin districts must reach at least "good" status by 2015 (Art. 4.1. (b)(ii) WFD).

Box 1: Definition of "good" status

Good groundwater status is achieved by a groundwater body when both its quantitative status and chemical status are good.

"Quantitative status" is an expression of the degree to which a body of groundwater is affected by direct and indirect abstractions. If this complies with Directive requirements the status is good.

"Good chemical status" is ascribed to a groundwater when it meets Directive requirements for the maximum levels of defined pollutants.

In order to achieve this good status, the member states have to take the following actions:

- Delineate and characterize groundwater bodies within river basin districts;
- Establish registers of protected areas within each river basin district (e.g., drinking water protected areas);
- Establish a groundwater monitoring network to overview groundwater chemical and quantitative status;
- Set up a river basin management plan for each river basin district;
- Take account of the principle of recovery of costs for water services, including environmental and resource costs;
- Establish a program of measures for achieving WFD environmental objectives.

[19] The EU member states subject to this study are: Austria, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxemburg, Netherlands, Poland, Romania, Spain, and Sweden. Malta was excluded, since it does not have any forest land.

A key component of these actions is the development of so called river basin management plans (Art. 13 WFD). These plans will be reviewed every six years and set out the measures required within each river basin to achieve set environmental quality objectives. This will involve a gap analysis where, for each water body, any discrepancy between its existing status and that required by the Directive is identified. A programme of measures can then be identified and put in place to achieve the desired goals.

Box 2: River basin management plans should include the following

- General description of the characteristics of the *river basin district*, including a map showing the location and boundaries of the surface and groundwater bodies and a further map showing the types of surface water bodies within the basin.
- Summary of the significant pressures and the impact of anthropogenic activity on the status of surface and groundwaters, including point source pollution, diffuse pollution and related land use, the quantitative status of water including abstractions and an analysis of other impacts of human activity on water status.
- Map showing any protected areas.
- Map of the monitoring network.
- Map of the results of the monitoring programme showing the status of all water bodies and protected areas.
- List of the environmental objectives set for all water bodies, including those where the use has been made of derogations.
- Summary of the economic analysis of water use.
- Summary of the programme or programmes of measures.
- Register of any more detailed programmes and management plans and a summary of their contents.
- Summary of the public information and the consultation measures taken, their results and the changes to the plan as a consequence.
- List of competent authorities.
- Contact points and procedures for obtaining background documentation and information, including actual monitoring data.

Based on Guidance Document No 1, Common Implementation Strategy for the Water Framework Directive (2000/60/EC).

Another key element of the WFD and its river basin management planning process is the requirement for an economic analysis (Art. 5.1. and Annex III WFD). The first stage of the economic analysis of a river basin district includes the following activities:

- Economic analysis of water use: This assesses how important water is to the economy and socio-economic development of the river basin district. It initiates investigations of likely trade-offs between socio-economic development and water protection.
- Economic input to the establishment of a base-line scenario: The investigation of the dynamics of the river basin districts will aid the assessments of forecasts of key economic drivers likely to influence pressures on water bodies and therefore their status. This includes reviewing changes in general socio-economic variables, key sector policies that influence water use, economic growth and planned investment linked to existing water regulation.
- Assessment of the current levels of recovery of the costs of water services: This concerns water service provision and the extent to which financial, environmental and resource costs are recovered, how cost recovery is organized and the way in which key water uses contribute to the cost of water services.

For the member states, this economic analysis, and in particular the assessment of the current levels of recovery of the costs of water services (Art. 9 WFD), is highly important in order to meet their obligation to impose a water pricing policy that encourages consumers to use water resources more efficiently. Pricing policies are meant to recover the costs of water services, including those relating to the environment and the use of resources. Although pricing policies are established in many EU states, others have less tradition of water pricing.

Box 3: Milestones of the WFD

2000: Water Framework Directive entered into force **2003:** Deadline for transposition in national law and identification of River Basin Districts and Authorities **2008:** Draft river basin management plan to be presented **2009:** River basin management plan including progamme of measures to be finalised **2010:** Pricing policies to be introduced **2015:** Environmental objectives to be met **2021:** First management cycle ends **2027:** Second management cycle ends, final deadline for meeting objectives

However, the WFD specifically addresses only the "quantitative status" for groundwater, while it does not address groundwater "chemical status". Instead, Art. 17.1. of the WFD builds the basis for the adoption of the Groundwater Daughter Directive (Directive 2006/118/EC[20]). This Groundwater Daughter Directive has replaced Directive 80/68/EEC and now deals with the chemical pollution and deterioration of groundwater. The Groundwater Daughter Directive has three pillars:

- Criteria linked to "chemical status" of groundwater, based on existing EU standards and threshold values for pollutants of risk to groundwater bodies which will be established by member states;
- Criteria to identify upward pollution trends in groundwater;
- Requirements for the prevention/limitation of inputs to groundwater (ensuring continuity with the original Groundwater Directive).

This EU regulatory framework related to groundwater, comprising the WFD as well as the Groundwater Daughter Directive, provides different instruments and concepts which have a great potential to promote the development of groundwater related PES schemes in the future:

First of all, the EU framework creates political support for countries aiming to prevent the further deterioration and to protect and enhance the status of aquatic ecosystems and, with regard to their water needs, terrestrial ecosystems (Art. 1 a) of the WFD). The objectives set by the framework already force the member states to become active and to adapt their legislation, institutional arrangements and policies to the standards set for groundwater related ecosystem protection. Also, the ambitious goal of reaching "good" groundwater status introduces a relatively high legally binding environmental standard. The WFD thus provides an instrument which introduces a "new ecological vision" and creates an incentive for member states to further improve their groundwater policies and legislation, potentially also by using market instruments for the conservation of groundwater related ecosystem services. Since the WFD provides flexibility in achieving its goals in the most cost effective way, the member states can apply different instruments, including PES, to meet their legal obligations. Compliance with and enforcement of the set environmental standard is also ensured through the monitoring procedures and review mechanisms foreseen by the EU legal framework. Such monitoring is recognized as one of the most critical aspects of establishing and operating PES, since it is needed to ensure the sustainability of PES.[21]

The obligation to develop river management plans is another key element of the EU legal framework that has the potential to promote the future development of PES schemes. The river basin unit – defined by geographical and hydrological characteristics – forms a sound basis of modern water management instead of organising water resources exclusively on the administrative or political level. The water resources themselves are emphasised, integrating all important environmental and socio-economic issues into the management plans, and therefore supporting an ecological and holistic oriented planning approach. Such sectorial integration, in particular with plans and programmes in the field of agriculture, rural and regional development, land use, navigation, hydropower and last, but not least, research is essential for an integrated water resources management approach. It provides a perfect opportunity to assess and value different ecosystems and their services, to identify the beneficiaries of these services (including the benefits of forest management for groundwater resources), and to build the case for the conservation of ecosystem services. In other words, integrated water resources management through the

[20] Directive 2006/118/EC on the protection of groundwater against pollution and deterioration has entered into force on 16 January 2007. It has to be transposed into national law until 16 January 2009.
[21] UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes (2007): Recommendations on Payments for Ecosystem Services in Integrated Water Resources Management.

development of river management plans can be a trigger for the creation of PES schemes in general, and forest-groundwater PES in particular.

Since the member states are required to ensure a full and comprehensive public consultation of all the issues covered by the plans, the planning process is also open for a multi-stakeholder involvement in the decision-making process. Such multi-stakeholder involvement is again important for the development of PES, since it ensures that potential sellers and buyers of groundwater related ecosystem services are informed, brought together, heard and have the chance to take influence on the planning process, as well as the development of the programmes of measures, including PES..

Finally, the required economic analysis and the concept of full cost recovery can be essential for efficient decision-making regarding the establishment of forest-groundwater PES. Among other things, the economic analysis should guide decision-making on which measures are employed to achieve good groundwater status and which measures should be used to achieve this objective in the most cost-efficient way. While the WFD does not state to which extent forest ecosystem services should be used for the achievement of environmental objectives, nor which scope the economic analysis should have in this regard, the importance of forest ecosystem services for the quantity and quality of groundwater resources should not be ignored.[22] Forests provide significant benefits that should be considered in river basin management decisions and also in the required economic analysis. To neglect these benefits and the possibility to introduce forest-groundwater PES schemes could lead to a misguided decision-making process and result in the choice of inefficient measures. Instead, the economic analysis could allow a comparision of the costs and benefits of changes in water-related ecosystem services in an integrated manner.

The principle of full cost recovery of water services, including those relating to the environment and the use of resources, could further promote the development of PES schemes. The question, however, is whether pricing policies that value ecosystem goods and services based on the concept of total economic value are covered by the principle of full cost recovery. This requires that forest ecosystem services are “water services” as defined in Article 2 (38) WFD. This definition states that “water services” are “all services which provide, for households, public institutions or any economic activity: (a) abstraction, impoundment, storage, treatment and distribution of surface water or groundwater, (b) waste-water collection and treatment facilities which subsequently discharge into surface water.” If a wide interpretation of this definition was applied, forest ecosystems could fall under such “water services” when they (indirectly) provide storage or treatment of groundwater to all users of the resource. An argument in favor of this wide interpretation can be found in Article 9.3 WFD which states that “nothing in this Article shall prevent the funding of particular preventive or remedial measures in order to achieve the objectives of this Directive.” The conservation of forest ecosystem services could be seen as such a preventive or remedial measure to protect a groundwater resource. As a consequence, it could be argued that forest ecosystem services are “water services” in the sense of Article 9 WFD which should be taken into consideration by the principle of full cost recovery.

National level

Since the objectives of the above described EU regulatory groundwater framework are legally binding for all EU member states, they shape the groundwater legislation of each member state and harmonize them across the EU. However, this harmonization process has not lead to all member states having uniform national water legislation. This is so, since the EU regulatory groundwater framework is not based on self-executing EU regulations or decisions, but on directives whose objectives are left to subsidiarity, hence to national water management practices. In other words, while the member states have to transpose the objectives of the directives into their national legislation, they are left with a certain amount of leeway as to the exact rules to be adopted.

As a consequence, the WFD and its Groundwater Daughter Directive are adopted by the member states through different laws, and are implemented by a varied set of authorities in each country. Also, the questions most important for this study[23] are regulated by a variety of laws, acts, regulations, decrees, etc. Depending on a

[22] See also the findings of Chapter 4.

[23] As mentioned before, answers need to be given to the following questions: who has a right to and therefore can be paid for the ecosystem services which are provided; who has to pay for the benefits received from the provided ecosystem services; and also who facilitates the development and implementation of PES agreements between the different parties involved (providers and beneficiaries)?

member state's administrative structure, it is not only the legislation related to groundwater but also the authorities responsible for its implementation that can be found at different administrative levels: national (federal government) level, provincial (federal state) level, as well as local (municipal) level. This leads to a rather diverse picture of the member states' institutional framework.

Table 2: Basic legislation related to and jurisdiction over groundwater

Country	Basic legislation related to groundwater	Jurisdiction over groundwater
Austria	National level: - Water Rights Act - Groundwater Protection Regulation Federal state (Länder) level: - NO State Water Acts	Execution of Water Rights Act: - Federal Ministry of Agriculture, Forestry, Environment and Water Management - State Governors - District authorities - Majors (in certain cases) Monitoring of Water Rights Act: - State Governors - District Authorities - In special cases, Federal Ministry of Agriculture, Forestry, Environment and Water Management Water supply and sewerage: - Local authorities - Possibility to organize public corporations (co-operatives and associations)
Bulgaria	- Water Act	Control of water quantity and quality, granting permits for water taking from large water sites: - Ministry of Environment Granting permits, monitoring, keeping water register, management of groundwater: - Director of Basin Directorate
Cyprus	- 2002 Water and Soil Pollution Control Law - 2004 Water Protection and Management Law	Planning, designing, constructing, operating, maintaining waterworks; selling water; fixing water tariffs etc.: - Government Issuing of permits for groundwater abstraction: - District Officer, with the consensus of - Director of the Water Development Department
Czech Republic	- 2001 Water Act	Administration of Water Act: - Water authorities and Czech Environmental Inspectorate - Central Water Authorities are: -> Ministry of Agriculture (in general) -> Ministry of Environment (in special cases, e.g. protection and monitoring of groundwater quantity and quality) - Regional authorities (expert advice, transboundary water management, issuing and control of permits) - Municipal Water Authorities (issuing permits)
Denmark	- Water Supply Act - Environmental Protection Act - Waste Water Order - Watercourses Act	Overall environmental protection, including coordination and management of water resources: - Ministry of Environment - Environmental Protection Agency (provides guidance for regional and local councils)
Estonia	- Water Act	Policy making, planning at national level, developing groundwater legislation: - Ministry of Environment Issuance of permits, managing the protection of groundwater quality, water registers: - 15 County Environmental Departments Monitoring: - Environment Information Centre Water supply: - Local authorities
France	National level: -Environmental Code - French Water Act - Civil Code - Public Health Code	- Ministry of Ecology, Sustainable Development and Town and Country Planning - Basin Committee (France is divided into six national basins) - Water Agencies (for the six basins) - Interministerial Water Mission - Coordinating prefect of the basin
	National level:	Groundwater protection and management:

Germany	- Federal Water Act - Groundwater Regulation - Certain provisions in the Federal Nature Conservation Act (regarding maintenance of the groundwater table) - New Environmental Code comprising water legislation planned for 2009 Federal state level: - State Water Acts (which regulate the management and use of groundwater sources)	- Federal Ministry for the Environment, Nature Conservation and Nuclear Safety is **NOT** responsible - Responsibility lies with the water authorities of the federal states (supreme, upper and lower water authority) Granting permits for groundwater uses if serious effects on groundwater are possible: - Supreme water authority of a state (usually State Ministry of Environment) Drinking water supply: - Responsibility of the local authorities Monitoring and disposal of sewage: - Federal states designate (district or local) authorities
Greece	- Law 3199/2003	Core responsibilities of coordinating water management, supervision, monitoring: - Central Water Agency (within the Ministry for the Environment) - National Committee on Water (representative from 5 relevant ministries) - National Water Council (24 representatives from various stakeholders; plays an advisory role) Implementation of law and policy at regional level; development of River Basin Management Plans: - Regional Water Offices - Regional Water Councils (40-50 representatives from municipalities, prefectures and stakeholders; advisory role in drafting River Basin Management Plans)
Hungary	- 1995 Water Management Act	Central governing body for environment and nature protection and water affairs - Ministry of Environment and Water Water supply: - Municipalities - Regional Water Management Council
Ireland	- Water Services Act 2007 - Local Government (Water Pollution) Acts 1977-1992 - Environmental Protection Agency Act - Constitution - Case law	Executing national WFD Groundwater Monitoring Programme, assessing general state of groundwater quality and quantity: - Environmental Protection Agency Protection and improvement of water quality, monitoring, development of Water Management Plans: - Local authorities
Italy	- Civil Code - 2006 Environmental Code (abrogating the 1994 Water Resources Act) - Numerous laws, regulations, decrees, at national, regional and local (provincial and municipal) levels	Groundwater management: - Ministry for the Environment Groundwater protection: - Ministry of Health Monitoring of water quality and quantity, regulating groundwater abstraction, granting permits for major abstractions: - Regional authorities Granting permits for minor groundwater abstraction: - Provincial authorities Development of Basin District Plans: - Basin authorities
Latvia	- Civil Law - Law on Water Management - Environmental Protection Law	Monitoring: - Minister of Environmental Protection
Lithuania	- Law on water	Issuing permits, environmental monitoring: - Ministry for Environmental Protection Environmental monitoring: - Local entities Monitoring quality of drinking water: - State Food and Veterinary Service under the Government of the Republic of Lithuania Keeping the public cadastre of groundwater: - Geological Service of Lithuania
Luxemburg	- 1993 Law Concerning Protection and Management of Water	Management and protection of water resources: - Ministry of Internal Affairs and Regional Planning (includes the Department for Water

	- Civil Code	Management) Coordination among different ministries, general planning of rational water use in the long-term: - Interministerial Committee Investment in sewerage/treatment: - Water Management Fund Communes are autonomous territorial bodies
Netherlands	- Civil Code - Groundwater Act - Water Management Act - Soil Protection Act - Environmental Management Act - New Water Act planned which will replace the Groundwater Act and the Water Management Act	Regulatory powers at regional level; integrated water management: - Provinces Protection of groundwater quality at local level: - Local authorities/municipalities
Poland	- Water Act (2001) - Several specific regulations	Coordinating water resource management and development: - Ministry of Environmental Protection, Natural Resources and Forestry, Department of Water Management Implementation of water resources management strategy: - 7 Regional Water Management Boards (in geographically determined river basins) - National Fund for Environmental Protection and Water Management Granting permits, collecting fees: - District authorities, voivodes - Local authorities, starosta
Romania	- 1996 Water Law - Law on Environmental Protection	Development of administrative processes for permit system: - Ministry for Water and Environment Protection Monitoring: - National Water Authority, Apele Romane Granting permits, management of drinking water supply and waste water discharge: - Local Environmental Protection Inspectorates (in close collaboration with river basin and provincial offices of National Water Authority)
Spain	- 1985 Water Act-, as modified by the real decreto legislativo 1/2001 (‘texto refundido de la ley de aguas’) - 1986 Regulation of the public water domain, as partially modified in 1992 and 1993	Autonomous Communities as far as the catchment area is completely within their territories; apart from that the federal state
Sweden	National level: - Environmental Code (1998:808) - Act (1998:812) containing special provisions concerning water operations County administrative board level: - Numerous provisions for groundwater protection Municipality level: - Numerous provisions for groundwater protection	Monitoring of provisions for groundwater protection: - County administrative board Granting permits: - Environmental courts

In general, it can be observed that, in the vast majority of the analyzed member states, the overall legal framework for groundwater related issues is set by national water laws. These national water laws use varied terminologies which are not consistent across the EU. National water laws can be found in the form of general Water Acts (e.g., Austria, Bulgaria, Czech Republic, Estonia, Lithuania, Poland, Romania, Spain), as well as Water Management, Water Protection, Water Pollution, Waste Water, Water Supply or Water Services Acts (e.g., Hungary, Ireland, Latvia, Luxemburg, Netherlands). It is interesting to note in this context that in some member states, the Water Act

is included in the country's general Environmental Code. This is the case, for example, in France, and also in Italy where the Environmental Code from 2006 has abrogated the Italian Water Resources Act from 1994.[24]

The varied terminologies indicate that the scope of the particular water laws is not consistent. However, it can be noted that they mostly lay out the general rules for governing all water resources of a country, surface water and also groundwater, but to varying levels of detail. Specific provisions only applicable to groundwater resources are usually included to address their distinct characteristics.

Also, in most of the countries, it is not just one national water law that builds the general legal framework (see also Table 2. Groundwater ownership structure below). Instead, distinct laws, for example the National Water Act in connection with the general Environmental Code, must be examined. Some member states do not even regulate the issue of groundwater ownership or the details of groundwater related compensation structures in their national water legislation. In countries, such as France, Germany, Ireland or Luxemburg, the water laws are silent regarding the question of who owns the groundwater resources. Instead, the groundwater ownership is regulated by the countries' Civil Codes, National Constitutions, or even court decisions.

In several member states, specific Groundwater Acts (e.g., in the Netherlands) or Groundwater Regulations (e.g., in Austria or Germany) can be found. The existence of such groundwater legislation does not mean that all legal issues related to groundwater are regulated therein. Instead, some specific questions related to management and use rights, or pollution and protection, are subject to these laws and regulations.

As mentioned before, depending on the administrative structure of a member state, groundwater related legislation and responsible authorities exist at several territorial levels, namely national, provincial or even local. In more centralized states, such as France, groundwater legislation is found mostly at the national level. In countries with a federal system, such as Germany, the Federal Water Act at the national level only creates a framework which needs to be implemented through further Water Acts at the provincial level (by the federal states). The necessary details of such provincial water laws can be again regulated in provincial regulations. Nevertheless, the existence of a federal government system does not necessarily lead to the development of water laws at both levels, national and provincial. While Austria, for example, is organized as a federal republic, no water laws exist at the federal state level.

In line with the diverse structure of the EU member states' groundwater related legislation and the dispersion of legislation at various administrative levels, the set up and responsibilities of those authorities in charge of groundwater governance are changing from country to country. Responsibilities for groundwater related policy making, legal drafting, implementation and monitoring can be found at the national, but also at the provincial and local level. At the national level, the water authorities are usually part of the Ministry of Environment. Close collaboration often exists with other ministries and agencies which are specially focused on forestry or health issues. In Denmark, for example, at the national level, the Ministry of the Environment and the Danish Environmental Protection Agency carry the responsibility for the overall environmental protection, including the coordination and management of water resources. The Environmental Protection Agency administers the legislation on water resource planning, provides guidance for the work of the regional and local authorities, and works in close collaboration with the Ministry of Food, Agriculture and Fisheries, the Forest and Nature Agency, as well as the Ministry of Health.

The granting of groundwater permits can also fall under the jurisdiction of national or provincial authorities. This sometimes depends on the size, importance or risks of the particular activity which requires a permit. In the case of Bulgaria, the Ministry of Environment is in charge of issuing permits for abstracting water from large water sites, while the Director of the Basin Directorate will grant all other permits. The issuing of groundwater abstraction permits can sometimes require a consensus of two authorities, such as in Cyprus where the District Officer needs to achieve a consensus with the Director of the Water Development Department.

Monitoring and control of the status of groundwater resources or the compliance with permit requirements will usually be the responsibility of the authorities at the provincial or local (municipal) level. Such decentralization is a preferred option in many member states, since those lower level authorities are located closer and linked more directly to the activities in the field. This may facilitate the implementation of monitoring and control activities and

[24] Germany is also currently developing a uniform Environmental Code which will comprise the Federal Water Act.

reduce bureaucracy. However, depending again on the importance, size or potential risk of a groundwater related activity, the responsibility for monitoring and control may also lie with a national authority.

Finally, it can be determined that the management of the local water supply is in general the responsibility of the municipal authorities.[25]

Despite the diversity of national institutional frameworks related to groundwater, it is important to note that the existing frameworks show characteristics which could support the development and implementation of PES agreements, if they are consequently applied. Ensuring a close collaboration between water ministries and agencies on the one hand and those entities which are focused on forestry issues on the other hand would be an important first step to facilitate the linking of groundwater and forest management matters. Such collaboration is necessary in a starting phase where it is crucial to identify the provided forest ecosystem services, to communicate their benefits for groundwater resources and to analyze options for integrated management approaches, including the development of PES policies and schemes. Furthermore, the institutionalization of such collaboration provides the basis for an effective and efficient operationalization of PES schemes once they are established.

The decentralization of monitoring, control and management of groundwater resources is another feature which could help in the implementation of PES schemes. Key for the success of PES is the design of management plans which reflect local circumstances and particularities, as well as monitoring and ensuring compliance with the agreed management obligations. If organized and implemented at a decentralized level, the necessary activities, such as stakeholder consultation and negotiation, field inspection or conflict resolution, are usually easier to undertake and more efficient.

However, it should also be pointed out that the still existing, "classical" distribution of authorities according to administrative and geographical boundaries (national vs. provincial, and between different provinces) can build an obstacle to the development of forest-groundwater PES schemes. In order to link forest ecosystem services and groundwater resources in the most efficient and effective way, it could be helpful to institutionalize so called "ecosystem services districts" instead. These districts would delineate certain authorities according to ecosystem services boundaries instead of political and geographic jurisdictions. Like this, they could establish conceptual government authorities which would be dedicated to the management of ecosystem services, provide a coherent and efficient governmental institution for monitoring and investing in natural capital, and even direct public investment into activities that enhance those ecological services that improve the condition of the district's groundwater resources.

2.2.2 Ownership and use rights regarding groundwater resources

While it is often assumed that groundwater resources are mostly owned by the public, the analysis of groundwater related legislation cannot fully support this perception. The issue of groundwater ownership is not regulated in a unified way in EU member states. According to the countries' legislation, three types of groundwater ownership can be differentiated:

- Public groundwater ownership;
- Public and private groundwater ownership;
- Groundwater as a "res nullius".

The first and biggest group of member states foresees that groundwater is exclusively owned by the state and therefore considers the resources as public. This is explicitly regulated in some national water laws (e.g., Cyprus, Greece, Hungary, or Poland). In other countries, the public ownership of groundwater resources is not directly defined, but can be concluded by interpreting the Civil Codes (e.g., Italy, or Latvia). In Germany, the Federal Constitutional Court has given a judgment in which it declares the public ownership of groundwater resources. This judgment is not explicitly reflected in the national water law, but only in a few provincial water laws.

[25] See, for example, an overview of the responsibilities regarding water supply and waste water treatment in the EU-15: Österreichische Gesellschaft für Politikberatung und Politikentwicklung (2003): Privatisierung und Liberalisierung öffentlicher Dienstleistungen in der EU-15:Wasser und Abwasser.

Table 3: Countries with public groundwater ownership

Country	Public groundwater ownership
Bulgaria	**Public ownership** - State ownership of underground waters except certain mineral waters regardless of whether they are located under state, municipal or private property - Municipal ownership of underground mineral waters not owned by the state
Cyprus	**Public ownership** - All groundwater vested in the state
Germany	**Public ownership** - Not explicitly regulated in the Federal Water Act BUT - Some of the State Water Acts regulate public ownership - E.g., *Bavaria*: Real estate owner does not own the groundwater resources; *Baden-Württemberg*: Real estate owner does not have the right to dispose of the groundwater resources; Lower Saxony: Real estate owner is not allowed to charge fees for groundwater use or to use it without authorization according to the Federal Water Act AND - Decision of the Federal Constitutional Court (BVerfG) which states that groundwater as a vital good is not subject to a regime under private law
Greece	**Public Ownership** - All water resources, including groundwater, belong to the state
Hungary	**Public ownership** See section 6: "The following shall be owned exclusively by the state: a) the subsurface waters..."
Italy	**Public ownership** - All water resources, including groundwater, are public - Private person can only obtain use rights - Water regarded as resource to be protected and used according to criteria of solidarity and preserving rights and expectations of future generations
Lithuania	**Public ownership** All the groundwater bodies belong to the public stock of internal waters and shall be considered the exclusive property of the State
Poland	**Public ownership** - Sea water, flowing surface water (rivers, streams) and groundwater are owned by the state - Only surface waters which do not flow can be owned privately or by water corporations
Romania	**Public ownership** - Public domain is owner of the groundwater resources

The legislation of a second group stipulates that groundwater resources can be owned by the public, but also by private persons. This legal approach can be found in several old EU member states (e.g., Austria, France, or Ireland), but also in some of the new member states (e.g., Estonia, and Latvia).[26] In these member states, the groundwater is either explicitly declared as public or private, or the real estate owner is considered as the owner of the resource below his land, thus also the groundwater resources. Again, the relevant provisions are found in the national water laws as well as in the Civil Codes of the countries. An interesting case in this group of member states is Spain where originally, all groundwater was under private ownership. According to the current Water Act, all groundwater resources are now declared as public domain. Nevertheless, an unknown number[27] of groundwater resources remains under private ownership, since all groundwater developments made before the Water Act came into force in 1985 may continue as private domain, using the same amount of groundwater as before.

It is important to note that the rights derived from such private groundwater ownership are of course not unlimited. The legislation foresees rights, but also duties, as it does for every private property. Because of its importance for the public, the private groundwater ownership is often marked by strong social ties and therefore can be considered as being close to a public good (e.g., Austria, or France).

[26] As mentioned before, this legal analysis does not claim to be complete, since it has not been possible to address all 27 EU member states.

[27] While all privately owned groundwater resources should be inventoried and registered, the number of all the grandfathered groundwater rights was underestimated so that the number of privately owned groundwater resources remains uncertain. See, Llamas, M.R. and Garrido, A. (2005): Lessons from Intensive Groundwater Use in Spain: Economic and social benefits and conflicts, in Karen G. Villholth; Mark F. Giordano: The Agricultural Groundwater Revolution.

Table 4: Countries with public and private groundwater ownership

Country	Public and private groundwater ownership
Austria	**Public and private groundwater ownership** - Real estate owner is owner of the groundwater resource (unless another person already holds an ownership right) BUT - Private groundwater ownership is marked by social ties (it is part of the public good) -Private groundwater can be declared as public water body, if required by public interest (does not qualify as expropriation)
Estonia	**Public and private ownership** Regulation § 5 (1) Water Act "Groundwater is state property" repealed in 2003
France	**Public and private ownership** - According to the Civil Code, the real estate owner is owner of the groundwater resource BUT - According to the Environmental Code, water is part of the common heritage of the nation, and protection, enhancement and development are of general interest
Ireland	**Public and private ownership** - According to the Constitution, the real estate owner is owner of the groundwater resource
Spain	**Public and private ownership** - All groundwater resources are declared **public domain** BUT - Until 1985 Water Act came into force, groundwater was private domain - According to 1985 Water Act, groundwater developments made before 1986 may continue as private domain

In addition, a third group of groundwater ownership can be distinguished, namely groundwater as a "res nullius". In this group, as long as the water is still underground, countries consider the resource as not being subject to anybody's property. In other words, neither public nor private ownership of the groundwater exists before it is abstracted and comes to the surface. The ownerless groundwater, however, generally becomes the property of the owner of the real estate where the water comes to the surface (e.g., Czech Republic, Luxemburg, or Netherlands). A different approach is taken in Denmark, where the ownership of the abstracted groundwater lies with the concession holder once he has abstracted it. In other words, in Denmark the groundwater is not owned by the owner of the land where the water comes to the surface, but by the permit holder who brings the water to the surface. The abstracted groundwater resources are then owned for the duration of the permit, which typically is 30 years in Denmark.

Like in the case of the first two ownership groups, this legal approach of res nullius can be found in the old EU member states, but also in at least one country from the new EU member states (Czech Republic). Again, the relevant provisions are included either in the countries' Civil Code or in the national water law.

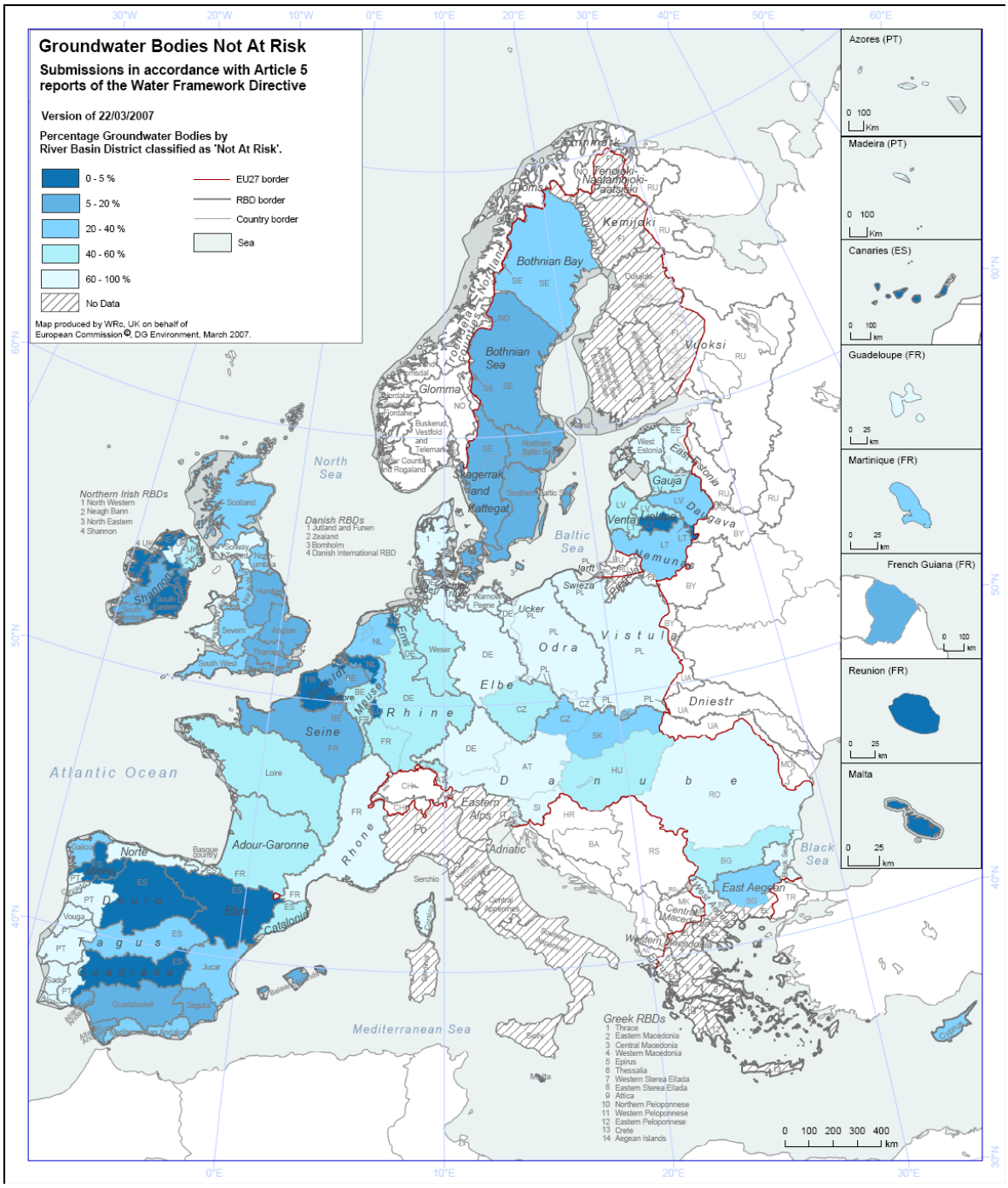
Table 5: Countries with no groundwater ownership

Country	No groundwater ownership
Czech Republic	**No ownership** - Groundwater is not subject to ownership and does not constitute a part or appendage of the plot of land on which or under which it occurs BUT - Groundwater withdrawn is no longer considered to be groundwater
Denmark	**No ownership** - Abstracted groundwater resources are owned by permit holder who brings water to the surface - Ownership for the duration of the permit
Luxemburg	**No ownership** - Nobody owns groundwater as long as it is groundwater and before it comes to the surface and is captured (= res nullius) BUT - According to the Civil Code, the real estate owner is owner of the groundwater that comes to the surface through springs, wells or pumps
Netherlands	**No ownership** - According to the Civil Code, the real estate owner is owner of the groundwater that comes to the surface through springs, wells or pumps BUT - Nobody owns groundwater as long as it is groundwater and before it comes to the surface (= res nullius)

However, the regulation of groundwater resources as public, public and private, or res nullius seems to have little impact on the status of the groundwater resources in the EU member states. As shown by the map below, groundwater bodies at risk of failing to meet the objectives of Article 4 WFD can be found all over the EU and independently of the existing groundwater ownership structure, For example, in the Netherlands and Luxemburg

(both countries with a res nullius groundwater ownership structure) a high percentage of groundwater bodies is at risk, while in most parts of Denmark (also a country with res nullius ownership structure) 60-100 % of the groundwater bodies are not at risk. Spain and Ireland, for example, face a high percentage of groundwater bodies at risk, while Austria has fewer problems. All three countries have regulated their groundwater resources according to public and private groundwater ownership structure, Poland and Lithuania, for example, both foresee public groundwater ownership only. But while 60-100 % of Poland's groundwater resources are not at risk, in Lithuania a high percentage of groundwater bodies is at risk.

Figure 2: Groundwater bodies not at risk



Apart from the question of who owns a groundwater resource, it is also important to have a clear understanding of who may use it. Different uses of groundwater resources are regulated in the member states' legislation. The most obvious use is the abstraction, amendment or redirection of groundwater for purposes, such as drinking water supply, agricultural irrigation, or simply lowering the groundwater table. In addition, the replenishment of groundwater resources as well as their use for discharging sewage is mostly regulated by the countries' groundwater related legislation.

Independent of the question of groundwater ownership, in all analyzed EU member states, the use of groundwater resources as well as related activities (e.g., the construction of hydro-technical facilities) generally requires a permit or concession. Such permits or concessions are usually issued in accordance with technical criteria relating, for example, to competence or experience, specified minimum distance requirements between wells and boreholes. Furthermore, the so created water rights are generally subject to a variety of conditions relating to their duration, monitoring, the quantity of water that may be abstracted and so forth, and may be lost through non-compliance with relevant conditions. Theoretically, a country's legislation could foresee that one of these conditions is to provide support for the conservation of ecosystem services which benefit the status of the used groundwater resource.

Apart from that, another similarity in the countries' legislation can be determined. In most of the member states, a limited use of a groundwater resource does not demand a permit or concession (see Table 5. below). In other words, the legislation typically provides that a formal right to abstract and use groundwater is not necessary for certain specified purposes, such as: abstraction and use of groundwater for stock and domestic purposes (e.g., Bulgaria, France, Italy, or Sweden), pumping and yield tests (e.g., Czech Republic), or emergency cases (e.g., Hungary, or Czech Republic). In addition, apart from serving a specific purpose, the legislation usually also requires that one or several other requirements are fulfilled. For example, only relatively small volumes of water may be abstracted (e.g., Bulgaria, France, Latvia, or Spain), abstraction can only take place without technical equipment (e.g., Estonia) or only with manual pumps (e.g. Austria), commercial abstraction and use is excluded (e.g., France, Italy, or Lithuania), and no serious negative impacts on the quantity and quality of the groundwater resource is expected. In a few countries (e.g., Greece, or Netherlands), all groundwater use requires a permit or concession.

Table 6: Groundwater use rights without permit

Country	Conditions
Austria	Public groundwater, if: - Ordinary use = use without specific devices and not compromising equal use by others, AND - Character of the water not endangered, no one harmed, legitimate rights not infringed, and public interest not affected Private groundwater by real estate owner, if: - Necessary for household or business use, - Abstraction only by manual pump or in adequate relation to the size of the property, AND - No interference with other legitimate use rights
Bulgaria	Common water, if: - e.g., use for personal needs, watering of animals AND - determined as common water by regional governor (states ownership) or municipal council (municipal ownership) Individual water - of landowners in settlements AND - if not exceeding 10 m^3/day
Czech Republic	- No permit required for -> pumping tests or yield tests for less than 14 days and not more than 1 l/s -> withdrawal for detecting and assessing the status -> in case of emergency, natural disaster, etc.
Denmark	Domestic use, if - property located outside public supply system - no imminent danger of low water quality or health risks - Land owner is permitted to lower groundwater level on own land to whatever depth necessary for cultivation purposes by construction of ditches and drains discharging into waterways without aid of a pump station
Estonia	Public water use: - abstraction without any constructions or technical equipment which could affect condition of water body
France	Use of water belongs to all within the framework of laws and regulations as well as previously established rights Domestic use without effect on the groundwater level

	- Criteria of domestic use is further defined, particularly volume of water below which use is considered domestic (<1000m^3/year) - Other uses are defined whose impact on the aquatic environment is too weak
Germany	Abstraction, delivery or conveyance to surface, or diversion, if for - Domestic purpose - Farming purpose - Use in small quantities for temporary purposes (regular use or use in irregular intervals not covered) - Normal drainage of land used for agriculture, silviculture AND - Uses are not likely to cause significant adverse effects on groundwater status
Hungary	Use of groundwater must consider that the balance of withdrawal and recharge shall be maintained without any adverse effect to groundwater quality -> Use is allowed in the order regulated in Section 15 (4) and starts with drinking, health and emergency response to disaster
Ireland	Domestic use, defined as - drinking - washing - heating and - sanitation
Italy	Domestic use, defined as - Drinking water, household, animal watering, watering of orchards and gardens - In an amount limited to the needs of the user and his family - Not for profit (annual volume not exceeding 1.500 m^3/year) BUT - Domestic use and volume of yearly abstraction must be notified to the provincial authority
Latvia	Personal needs (if amount does not exceed the limits fixed by the Cabinet of Ministers)
Lithuania	Use of water of drilled well, § 26 (3)
Luxemburg	Abstraction of groundwater as well as groundwater discharge, if - negligible quantities, and - negligible harm
Romania	Drinking, watering, washing, bathing and other household needs, if - no installations, or - low capacity installations are used of less than 0.2 liter/sec
Spain	Drilling for abstraction of less than 7000m^3/year, unless aquifier system has been declared overexploited, or at risk of being overexploited, then abstraction only with permit
Sweden	Water abstraction - for the personal consumption of a one- or two-family property or agricultural and forestry property - where public or private interests are manifestly not harmed by the impact or water operations on water conditions

Exemptions for small groundwater uses are generally justified on the basis that their use will have little or no impact on the total available water supply.

2.2.3 Compensation structure

According to Art. 9 of the WFD, the EU member states are asked to “take account of the principle of cost recovery of water services, including environmental and resource costs”. Furthermore, the member states shall ensure by 2010 that “water pricing policies provide adequate incentives for users to use water efficiently, and thereby contribute to the environmental objectives of the WFD.” As mentioned before, this principle of cost recovery provides the possibility to establish pricing policies that value ecosystem goods and services based on the concept of total economic value.

While the reform of national water pricing policies is still an ongoing process, this study analyzes who currently has to pay for the benefits received from the provision of groundwater resources, who collects these payments, and if the revenues are dedicated for a special environmental purpose. The answers to these questions give an idea whether the already existing pricing policies have a potential to support the development and implementation of PES schemes. It is clarified which financial resources are available, and which institutional structure exist in this respect.

Who pays for the provision of groundwater resources?

Again, it must be noted that while the compensation structure varies from country to country, some similarities can be identified. It can be determined that in all member states, usually all of the various groups of groundwater users, such as private households, industries, and the agricultural sector, are obliged to pay for the utilization of groundwater resources. However, in those cases where the groundwater use does not require a permit, no fees

are generally charged (e.g., Austria, Bulgaria, Estonia, Ireland). Also, an exemption from the duty to pay a fee may exist for the abstraction of small quantities of water (e.g., Czech Republic).

An increasing number of fees and also taxes are being paid by the water users. Fees are collected for both, abstraction and pollution of groundwater. The abstraction fees are mostly calculated by volume by multiplying a given unitary rate by the quantity of water abstracted (e.g., Bulgaria, Estonia, Germany, or Netherlands). In other countries, the abstraction fees are associated with the abstraction permit or concession and based on the maximum quantity of water to be abstracted by the water user as laid down in the permit or concession (e.g., UK). This system of volumetric charging can, however, only work, if water metering is required. While water metering is still not everywhere the norm (e.g., in UK households)[28], some member states charge already a special fee for the rental of the meter (e.g., Ireland, or Luxemburg).

The rates charged to each user group normally differ. In particular, the use of groundwater for agricultural purposes benefits from lower rates or tax exemptions in a number of countries (e.g., Greece, or Netherlands). Rates can also differ between abstraction and consumption fees, putting a higher rate on consumptive use. Lower rates can be found with regard to areas without over-abstraction, specific industry sectors and even scarcity situations.[29] Finally, it is important to mention that in many countries, the abstraction or consumption of groundwater is charged at a higher price than the same use of surface water.[30]

Pollution and emission fees are also widespread in the EU member states. However, exemptions exist in some countries where a fee must only be paid for discharge into surface water, but not into groundwater (e.g., Netherlands). The rate of the fees can be calculated again according to volume, i.e. the amount of individual contaminants lead into a groundwater body (e.g., Bulgaria), or based on the maximum allowances of pollution permits. Because of difficulties of assessment, less pollution fees are found for the agricultural sector. However, in some member states, taxes directly on fertilizers and pesticides are levied in order to reduce agricultural pollution (e.g., Denmark, or Sweden).[31]

Also, a diverse set of other taxes or fees exist in different member states. Those can come in the form of taxes or fees for the connection to the water supply or sewerage system, green taxes for drinking and waste water which are charged in addition to the general drinking and waste water fees, an additional “Water Penny” for the use of groundwater (see Box 4. below), or value added taxes which, however, are sometimes charged at a reduced rate. Finally, it must not be forgotten that revenues come also from the payment of fines which are charged for pollution or non-compliance with the granted permits and concessions.

Box 4: The German Water Penny

The model of the German Water Penny (Wasserpfennig) has been applied in the German federal states Hessia, Lower Saxony, North Rhine-Westphalia and Baden-Württemberg. The underlying idea is that farmers are compensated by water supply companies if their farming practices are impaired by groundwater protection requirements. This compensation is levied from all customers of the water supply companies; the level of compensation is determined through negotiations between farmers and water suppliers either on the municipal or on the sub-state level. The pitfall of this instrument is that, in order to calculate the level of compensation, the common standard for agricultural practices has to be defined first which creates an incentive to lobby for a definition that is based on very intensive agriculture, since this will increase their compensation. A second drawback relates to the cost of monitoring: the payment of the compensation means that farmers are legally obliged to change their practices, yet the actual compliance can only be verified through extensive and expensive monitoring.

Are the payments dedicated to a special environmental purpose?

For the development of forest-groundwater PES schemes, it is important to know whether the so collected financial resources could be dedicated to a special environmental purpose, namely, the conservation of forest ecosystem

[28] Pierre Strosser and Stefan Speck: Environmental taxes and charges in the water sector. A review of experience in Europe.
[29] Id.
[30] Id.
[31] Id.

services that benefit groundwater quantity or quality. In this regard, the implementation of the WFD and its principle of full recovery of the costs of water services, including environmental costs, will have more and more impact on the countries' groundwater compensation structure in the future. Especially in the member states that have recently joined the EU and adopted the Acquis Communautaire, fees dedicated to the environment have already been incorporated in the water legislation. A part of the collected fees is often earmarked to environmental funds or environmental agencies (e.g., Bulgaria, Czech Republic, or Hungary). But also in the old member states earmarking of receipts from abstraction or pollution fees can be found (e.g., France, or Germany).

However, in some member states, the main focus of the collection of revenues seems to be still on financial cost recovery and traditional water services, and only little attention is given to the issues of environmental and resource costs (e.g., Greece, or Italy). Also, it is important to note that in the particular case of the UK where the whole water sector has been privatized, the government does not permit to pass on costs for compensation payments under voluntary agreements to consumers.[32]

As a consequence, it has to be concluded that in some EU member states a part of the water charges are already dedicated to cover environmental costs. In those countries there is a potential to set up funds which could be used to finance PES schemes. Again in other member states cultural, political or even legal barriers still exist which prevent such dedication and therefore provide an obstacle to the development of forest-groundwater PES schemes.

Who collects the payments?

Finally, it is interesting to explore which entity collects the payments made for the provision of groundwater resources. As explained above, such funds might be dedicated to environmental purposes, including the conservation of forest ecosystem services. Therefore, the collecting entity has the potential to become an intermediary who facilitates the development and implementation of PES schemes by linking the charges paid by the water users to providers of groundwater related forest ecosystem services.

The responsibility for collecting the revenues as well as their dedication for a special purpose depends on several factors. One of these factors is whether the money comes from taxes, fees or fines. The taxes are exclusively collected by a governmental body. Private entities are not involved in their recovery. The responsible governmental bodies can be found at all levels, from national to local, depending on the taxing authorities. Although the so called "green" taxes are paid in some countries (e.g., Denmark) indicating that the money is dedicated to a general or specific environmental purpose, it should be kept in mind that the revenues from green taxes generally go first to the funds of the national, state or local government. Such merging of green tax revenues with other tax revenues creates the danger that some of the money might be diverted to finance non-environmental purposes and therefore used inconsistent with its actual dedication. While the risk of "misusing" tax money always exists, this is generally lower, if the money is directly paid to a special environmental fund.

In most of the member states, the fees charged for a water service are collected by the entities which provide the service. If the public supply lies in local authorities' hands, mostly the municipalities, the revenues will be collected by them. In some member states, however, the fees are collected by national and regional authorities, such as the Ministry of Environment or the Basin Directorates (e.g., Bulgaria).

The ongoing privatization of the water markets in most of the member states has also a great influence on the collection of fees for water service provision. More and more private operators or public-private water companies (companies which are owned by the public, e.g. the municipalities, but are organized as economically independent entities under private law) are in charge of the water management and supply. In those cases, the revenues for water service provision are collected by the private or public-private entities. It is interesting to note that in the UK, for example, the water sector has been fully privatized since 1996, while in a few other countries (e.g., Luxemburg, or Sweden), no private companies or public-private-partnership exist in the water management.[33] Furthermore, it is important to know that in a number of countries, local authorities have the possibility (generally not the duty) to gather at a local or regional scale in order to provide more efficient services (e.g., France, Germany, Italy)**.**

[32] I. Heinz (2008): Co-operative agreements and the EUWater Framework Directive in conjunction with the Common Agricultural Policy, at http://www.hydrol-earth-syst-sci.net/12/715/2008/hess-12-715-2008.pdf .

[33] Österreichische Gesellschaft für Politikberatung und Politikentwicklung (2003): Privatisierung und Liberalisierung öffentlicher Dienstleistungen in der EU-15:Wasser und Abwasser.

2.3 Overview of legal frameworks related to forest at EU member states level

2.3.1 Institutional framework

In contrast to the member states' institutional frameworks related to groundwater, their institutional frameworks related to forest are less influenced and guided by EU policy. The responsibility for forest policy lies with the member states. However because of a growing concern about the coherence between the forest policies of the member states and forest-related activities at the EU level, in 1998, the Council adopted a resolution on a forestry strategy for the European Union. This strategy established a framework for forest-related actions in support of sustainable forest management and emphasized that the EU can contribute to the implementation of sustainable forest management through common policies, but based on the principle of subsidiarity and the concept of shared responsibility.[34] The EU Forestry Strategy highlights the importance of the multifunctional role of forests for the development of society, and identifies a series of key elements, which form the basis for its implementation.

In order to facilitate the implementation of the EU Forestry Strategy, in 2006, the EU Forest Action Plan was adopted.[35] The five-year Action Plan (2007-2011) consists of a set of key actions which the Commission proposed to implement jointly with the member states. The action plan is centred around four objectives:

- Improving the long-term competitiveness of the forestry sector,
- Protecting the environment,
- Improving the quality of life, and
- Fostering intersectoral coordination and communication.

In order to achieve this, 18 key actions have been recommended which are to be implemented over the five years. While the EU Forestry Strategy and the EU Forest Action Plan play an important role in coordinating at the EU level, they do not lead to a unified institutional framework in the member states.

Despite this lack of harmonization, some similarities between the member states' institutional set-up can be determined. All institutional frameworks recognize that forests provide a multitude of functions, and that forest governance is closely connected with and largely influenced by other issues, such as agriculture, food, trade, rural development, environmental protection, etc. Therefore, in many countries the competences over forests are assigned to ministries which are also responsible for agriculture, fisheries, food, nature or environmental matters in general (e.g., Austria, Bulgaria, Czech Republic, Denmark, Germany, Poland, Lithuania).

Another implication of this interrelation between forest governance and other issues is the necessity for inter-ministerial coordination and collaboration. As a consequence, different ministries have in general a strong say in forest related policy- and decision-making processes. For example, in the Netherlands the Ministry for Agriculture, Nature Management and Fisheries holds the main responsibility in relation to forest governance, but forest policy is also influenced by the Ministry of Economic Affairs and the Ministry of Housing and Regional Planning. In Germany, decisions are influenced not only by the competent Ministry for Food, Agriculture and Forestry, but also by the Ministry of Economics and the Ministry of Environment. In Bulgaria, the Ministry of Agriculture and Forests is primarily responsible. However, other ministries which have an influence on forest related decisions in Bulgaria are the ones responsible for environment and water, interior, finance and justice, as well as the regional development and public works ministry. In other countries (e.g., Cyprus), the Council of Ministers is competent when it comes to certain forest governance decisions. This attempt to facilitate an integrated decision-making approach is made by all EU member states.

A further commonality can be seen in the institutional role of forest related research bodies and the influence of different stakeholder groups in forest policy-making. The responsible ministries as the main policy-making bodies are often advised by or draw from the expertise of specific research bodies. For example, Forest Research is an agency of the UK Forestry Commission and the UK's principal organization for forest research. Through Forest Research, the UK Forestry Commission supports the British Ministry of Agriculture, Fisheries and Food by advising on forest policy. The Romanian Natural Forest Research and Management Institute (ICAS) is another example.

[34] Council resolution of 15 December 1998 on a forestry strategy for the European Union.
[35] Communication from the Commission to the Council and the European Parliament of 15 June 2006 on an EU Forest Action Plan.

ICAS belongs to the Romanian Forest State Administration and is responsible for different research areas related to forestry: forest health monitoring; biodiversity restoration and conservation; silviculture and nurseries; ecological and biological reconstruction; forest and wildlife management; botany; and genetics. Through its research and project activities, ICAS participates in promotion and endorsement of environmental policies in Romania. The particular role of these research bodies is often determined in the forest legislation. In addition to such scientific bodies, a large number of organizations and associations concerned with forestry have an important influence on forest policy-making. Such groups include, for example, small private forest owners associations, organisations with a primarily environmental interest, the private timber industry, or forest sector labour unions.

All the analyzed EU member countries dispose of specific forest legislation, except for Luxemburg where forests are regulated within the general Environmental Code. In all country legislations, the importance of forests as a part of nature conservation is expressly stated. According to the legal system of the country, forest legislation may exist at the national level, as well as at the sub-national, provincial level. Examples of the latter system are Austria, Germany, Italy, and Spain. In Greece, forestry is even addressed in the country's constitution which prohibits changing land use in state forests and forest areas, except for certain circumstances.

Forest legislation is furthermore influenced and complemented by a number of non-forest specific legal acts, such as laws on nature conservation and landscape protection, natural resource management, land use planning and land development, wildlife conservation, hunting, game protection and management, plant health and pest control. Regarding the new EU member states, especially laws relating to the privatization and restitution of (forest) property which have been enacted in many Eastern European countries in the course of the political changes in the 1990s play an important role. An interesting case is also provided by the UK forest policy. The UK forest policy differs from that of other EU countries insofar as it is of a rather informal kind. Rarely, specific Forestry Acts of Parliament are promulgated (the most important one in 1919, the last one in 1967). Since then, there has been a movement towards a multiplicity of objectives, driven largely by more general legislation such as wildlife and countryside protection and management.

Depending on the legal system of each member state, forest law-making can be the responsibility of the national government, the provincial governments, or both. In the first case, for example in Austria, the national forest law comprises all forestry activities and generally ranges from tending, maintenance, harvesting operations to forestry education as well as subsidies. In the second case, like Spain, almost all matters relating to forests are regulated by the legislation of the autonomous communities and only very few issues, such as national parks and large-scale subventions and investments, are addressed by the national forest law. In the third case, for example in Germany, the national forest law sets the basic legal framework for forestry. These basic guidelines are then specified, elaborated and, if needed, supplemented by the forest laws of the provincial states.

The responsibility for forest law-making has to be distinguished from the execution of the forest legislation. The authorities responsible for the execution of forest legislation vary significantly from member state to member state. They can be found at all administrative levels: Some countries have chosen to leave the responsibility for executing forest legislation mainly with national governmental bodies. For example, in Denmark, the Ministry of the Environment and Energy is among other issues, responsible for deciding whether an area is considered as a forest reserve, or suitable for good and multiple-use forestry and therefore subject to a forest reservation duty. It also decides on the provision of state subsidies for the forestry sector and supervises the compliance with the Forest Act and the rules issued pursuant to the Act. In France, for example, the Ministry of Agriculture is in charge of approving the management plans for public and community forests written under the responsibility of the French National Forest Service (Office National des Forêts). The ministry also ensures that the operations planned for the forest are conformed to the general guidelines defined by the national or regional forest policy.

Other countries have opted for more decentralized responsibilities regarding forest law execution. In Italy, for example, such a decentralization process has been followed at least in parts of the country. Some regional authorities (mainly in the North and Centre of Italy) have taken advantage of the "autonomy" granted by the national government and have organised regional or even local forest services. Other regional authorities (mainly in the South) are still making use of the forest service of the national government for the implementation of their forest policies.[36] Austria provides another example for a decentralized execution of the forest legislation. Here the forest legislation is under so called indirect execution by the federal government (mittelbare Bundesverwaltung) which

[36] See Pelkonen, P., A. Pitkänen, P. Schmidt, G. Oesten, P. Piussi, and E. Rojas (2000): Forestry in Changing Societies in Europe. Study Book Part II: Country Reports.

means that the district governor (*Bezirkshauptmann*) is responsible at first instance. Only for very specific issues the provincial governor (*Landeshauptmann*) or the federal governmental ministry are responsible.[37] In the UK, the Forestry Commissions for England, Scotland and Wales are the government bodies not only advising on but also implementing forest policy. Responsible to the Minister of Agriculture, Fisheries and Food and the Secretaries of State for Scotland and Wales, they are in charge of executing the UK's forest legislation, for example, by granting licences for tree felling, approving longer term management plans, investigating suspected illegal felling, or certifying suppliers.

2.3.2 Forest ownership structure and rights and duties of forest owners regarding groundwater resources

Understanding the forest ownership structure as well as the rights and duties of forest owners is important for the development of forest-groundwater related PES, since it indicates

- which obligations already exist regarding the provision of groundwater related forest ecosystem services, and
- who has a right over the forest and therefore can be paid for the ecosystem services which are provided.

Obligations of forest owners

The forest legislation in the analyzed countries identifies a number of obligations of forest owners. All countries' forest laws oblige forest owners to properly and sustainably manage their forests, while the specific principles enforced differ to a certain extent. The general principles include obligations to re- and afforest within a certain time period after fire, felling or other causes, to undertake sanitary felling, and to avoid and prevent damages to the forest. Also, owners are generally obliged to obtain permits for harvests, to abstain from changing forests substantially, and to follow the requirements of a forest management plan. Regarding the latter, in some countries, forest owners of a certain forest size are required to do forest planning (e.g., France), while in other countries, forest owners are generally not required to elaborate or follow a forest management plan unless they wish to obtain grant aid or felling permissions (e.g., UK). In still others, all forests must have a management plan.

These obligations are kept rather broad and are not specifically directed at the maintenance and protection of groundwater. However, a link between forest and groundwater resources management can be established in the forest legislation of all member states. The countries' forest laws explicitly recognize the protection of water resources, and therefore also groundwater resources, as an important function of forests. As a consequence, the above described obligations of sustainable forest management have to be interpreted in light of this forest function. This can have an important impact especially on the development of forest management plans which should reflect the different forest functions and therefore also the interest of groundwater protection.

Also, the legislation of some countries contains more groundwater specific regulations. Such regulations in forest laws can include the duty of forest owners to use for example only environment friendly, biodegradable oils and liquids when working in the forest, to carry out forest management only in cooperation with specifically trained forest managers and to keep a forest management record (e.g., Czech Republic). In Estonia, for example, forest owners are required to regulate the water and nutrition regime of the forest soil in compliance with environmental protection requirements. It is prohibited to fertilize forests with directly effective mineral fertilizers, and management must be carried out in a way so as not to endanger or damage the water regime.

Further forest regulations which can seriously improve the groundwater resources management regard the possibility of forest clear-cutting. It should be mentioned that in some countries, private forest owners are allowed to do clearing of up to 4 hectares of forest without the need to obtain a permit (e.g., France). Nevertheless, even in those cases, the clearing can usually be prohibited for specific reasons like woodland protection or conservation.

Less relevant at first sight in the groundwater context, is the right of the general public to enter forests for recreational purposes which is foreseen or at least generally accepted in most EU member states.[38] Especially in

[37] See Federal Ministry of Agriculture, Forestry, Environment and Water Management (2004): Nachhaltige Waldwirtschaft in Österreich, at http://forst.lebensministerium.at/article/articleview/36896/1/5827 .

[38] It should be noted that in some countries the private forest owner is allowed to exclude the general public from entering his forest (e.g., France, or Estonia), while this is not possible in other countries (e.g., Germany, or Latvia).

Eastern European countries, it is also possible to collect fruits, mushrooms, animals except from game, or even waste wood for personal use without a permit (e.g., Poland, Bulgaria, or Czech Republic). While such permitted uses might be unlikely to have an impact on the groundwater regime, it should be noted that people entering the forest still carry the general obligation not to damage the forest. This general obligation is even more concretized in some countries that forbid forest visitors to disturb the forest water regime (e.g., Czech Republic).

Most important for the development of forest-groundwater PES schemes can be regulations that oblige natural and legal persons as well as public institutions who benefit economically from the effects of forest protection functions to pay to the forest units the equivalent value of these effects. This is for example the case in Romania.

Finally, regulations addressing both, forest and groundwater resources, can also be found in the water related legislation of most countries. The water legislation generally foresees the designation of drinking water areas in which main infiltration to the groundwater reservoir takes place. Within such areas detailed mapping of land use, pollution threats and the natural protection of the groundwater resource usually takes place which leads to restrictions in land use and other human activities afterwards. Furthermore, provisions under such water laws foresee the possibility for authorities to enter into agreements with landowners for regulating their (agricultural or forest) practices, purchase property, etc., and clarify the question of compensation for loss of income, sale of land or property.

Who needs to be paid under a PES scheme?

This leads to the question who the forest owners are who have to be compensated under such PES schemes. In the European Union of 27, the total land area is 420 Mha. The forest area covers 156 Mha – 37% of the territory. 59% of the forest area is managed by private entities (individuals and enterprises), who own on average a forest area of 5 ha each. The remaining 41% is in the public sector and shared between 40,000 municipalities, local and national authorities.[39]

In all analyzed member states, forests can be under public as well as private ownership. However, the ratio between the two different forms of ownership differs significantly. For example, in Austria only about 20% of the country's forests are publicly owned, whereas in Bulgaria this is the case for 90% of the forests.[40] Public owners can be found at various administrative levels of a country, from national to regional to local entities. Private owners can be individual persons as well as companies of the wood industry or of the Catholic Church.[41]

It must be recognized that all of the new EU member states, except Poland and Hungary, have engaged in some form of restitution of land rights to former owners. These countries can be divided into two groups[42]:

- Those that re-established the ownership rights of individuals whose land had not been expropriated, and also restituted a much smaller portion of land that had been held by the State (e.g., Czech Republic); and
- Those that restituted land to former owners only (e.g., Bulgaria, Romania).

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[39] See EUROFORNET, at http://www.euroforenet.eu/wp-content/uploads/File/Euroforenet_Last_EN_small.pdf .
[40] See Pelkonen, P., A. Pitkänen, P. Schmidt, G. Oesten, P. Piussi, and E. Rojas (2000): Forestry in Changing Societies in Europe. Study Book Part II: Country Reports. UNECE/FAO Private Forest Ownership Enquiry (2007), at www.euroforenet.eu/wp-content/uploads/File/EUROFORENET_UNECEFAO_FHirsch_SHetsch.ppt .
[41] E.g. in Sweden, 39% of the forest is owned by forest companies, 10% are publicly owned, and 51% by individual private persons.
[42] See R. Giovarelli, D. Bledsoe (2001): Land Reform in Eastern Europe: Western CIS, Transcaucuses, Balkans, and EU Accession Countries, at www.fao.org/docrep/007/AD878E/AD878E00.HTM .

Figure 3: Countries with predominance of public forest ownership[43]

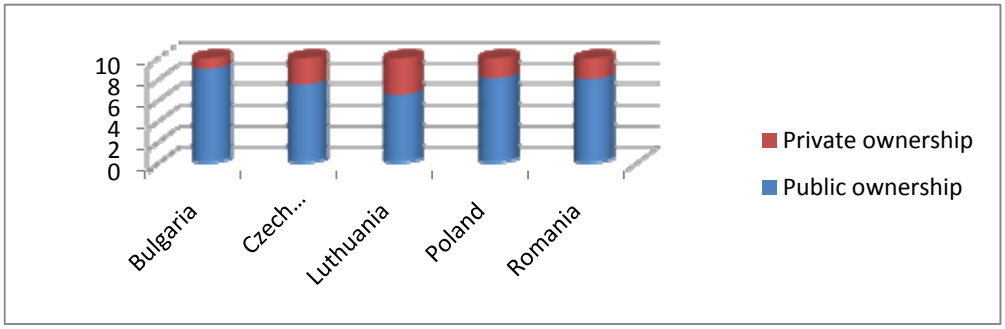
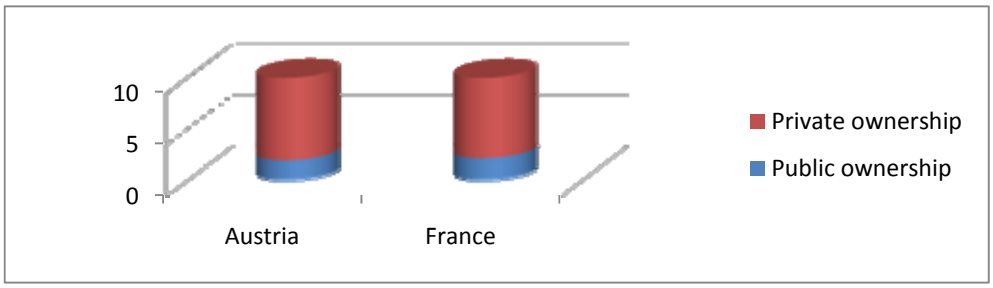


Figure 4: Countries with predominance of private forest ownership[44]



Thus, forest owners who provide groundwater related ecosystem services and therefore can become sellers in forest-groundwater PES schemes are private, but also public entities.

2.4 Conclusion

The above provided analysis shows that the WFD as well as the legislation of several EU member states have the potential to promote the development of future forest-groundwater PES and to provide a legal basis for such schemes.

The WFD can be interpreted as an incentive for member states to include PES schemes for the conservation of groundwater related forest ecosystem services in their groundwater policies and legislation. The obligation to develop river management plans supports an integrated water resources management approach and provides an opportunity to build the case for forest-groundwater PES. Also, the required economic analysis and the concept of full cost recovery could influence the decision-making in favour of the establishment of forest-groundwater PES. However, in order to tap the full potential of the WFD for the development of such PES schemes, it needs to be clarified that

- forest ecosystem services should be used for the achievement of environmental objectives and therefore need to be considered by the economic analysis and in river basin management decisions, and
- forest ecosystem services are “water services” as defined in Article 2 (38) WFD and therefore part of the principle of full cost recovery.

In the forest as well as groundwater related legislation of EU member states, different legal instruments can be identified which directly oblige forest owners to take protection measures for groundwater resources. Apart from the possibility of designating groundwater protection areas which prohibit certain forest uses, other groundwater related obligations of forest owners (e.g., limitation to do clear-cutting) can be found. In this context, it is usually not decisive, if the forest owner is also the owner of the groundwater resources. Since groundwater bodies are generally considered important resources for drinking water supply, the public interest in their protection often

[43] UNECE/FAO Private Forest Ownership Enquiry (2007), at www.euroforenet.eu/wp-content/uploads/File/EUROFORENET_UNECEFAO_FHirsch_SHetsch.ppt .
[44] Idem.

prevails over the vested property rights. As a consequence, regardless of public or private forest ownership, as well as the country's legal approach to groundwater ownership (public ownership, public-private ownership, and res nullius), forest management has to take possible impacts on groundwater resources into account.

It might be argued that such advanced "forest-groundwater" protection schemes could limit the demand for or attractiveness of setting up payment for environmental services schemes. However, several countries combine both in their legislation, legal obligations to protect forests for groundwater purposes as well as legal instruments which provide an opportunity to develop future PES schemes. Regarding the latter, it needs to be highlighted that some countries' legislation explicitly stipulates that the beneficiaries from forest protection shall pay the equivalent economic value of the received forest services to forest owners. In addition, the possibility of designating groundwater protection areas can play an important role. Such designation is at first sight a traditional command and control instrument. But, as will be shown in chapter 3 below, it can also provide the basis for the development of PES schemes. While within these areas groundwater resources are protected through restrictions on land use and other human activities, such restrictions can go hand in hand with compensation payments for necessary changes in forest management practices, lost income, or even purchased land.

The groundwater compensation structures in EU member states also show clear possibilities for introducing payments for environmental services. Eco-taxes are already used in a number of countries to collect funds for environmental protection measures. Yet, in most of the member states, such revenues are not dedicated to support sustainable forest management. Instead, the need for further improving the waste water infrastructure is often the main priority. Green fees can also be charged to groundwater users. In such cases, it is important to earmark the revenues to specific environmental funds as it is already being done in several countries. Dedication of taxes or fees to such earmarked funds can reduce the likelihood that the collected money simply contributes to the general budget of the state, provinces or municipalities and is "misused" for other purpose. In line with Art. 9 WFD, additional taxes or fees specifically dedicated to support forest-groundwater related PES schemes could and actually should be charged. However, it is important that the water suppliers have the right to pass on those environmental costs to their customers.

Finally, it should be mentioned that although the forest and groundwater related legal frameworks differ considerably from member state to member state, it is possible to find a clear answer to each of the following questions:

Who has a right to and therefore can be paid for the ecosystem services which are provided?

- The owners of forests which provide groundwater related ecosystem services can become sellers in forest-groundwater PES schemes. Forests in EU member states are either owned by private or public entities.

Who has to pay for the benefits received from the provided ecosystem services?

- In all EU member states, usually all groundwater users (private households, industries, and the agricultural sector) are obliged to pay for the utilization of groundwater resources. Such payments are sometimes dedicated to environmental purposes.

Who facilitates the development and implementation of PES agreements between the different parties involved (providers and beneficiaries)?

- The entity which collects the payments made for the provision of groundwater resources has the potential to become an intermediary who facilitates the development and implementation of PES schemes by linking the charges paid by the water users to providers of groundwater related forest ecosystem services.

While this might be considered as a given in EU member states, this is not always the case in other parts of the world where property and tenure rights are less clear, water services are not charged or charges are not enforced, and institutions are not functioning because of unclear authorities. However, it must also be said that the frameworks of some member states show a need for consolidation which would make the actual implementation of especially groundwater related legislation much easier. Such undertakings are ongoing in a number of countries, but not yet all.

3 Groundwater and forest related PES schemes in EU Member States

This chapter will give an overview of the information collected on PES schemes related to groundwater and forest in different EU member states. The next section will describe the process of data collection and its limits. This will be followed by an overview and comparison of existing case studies for PES schemes in four EU member states and will give a brief overview of a number of envisioned projects in the final section of the chapter.

3.1 Collection of case study information

The objective of this study is based on the assumption that groundwater and forest related PES schemes exist within EU member states. According to various respondents to the request for information, only very limited knowledge exists about functioning PES schemes related to groundwater and forest in the EU. Many examples of PES schemes can be found in relation to agriculture, for example the compensation of farmers for environmentally friendly land management practices. However, the objective of this study as given in the tender description from the European Commission, aims at having an overview of ownership and financial compensation for the ecosystem services provided by groundwater resources in European forests. In annex 1 an overview of the availability of groundwater in each of the EU member states is provided, which shows a great variety and consequently a different level of priority in the need to develop new mechanisms for groundwater protection and payment. Annex 2 provides an overview of the experts, organisations and networks contacted to collect information and case studies, as well as a short description of the responses. This shows clearly that many stakeholders in EU member states are not aware of existing PES schemes in their countries.

3.2 PES schemes on groundwater and forest implemented

The following case studies describe functioning PES schemes on groundwater and forest in Denmark, Austria, Germany and Spain. The information is based mainly on returned questionnaires with additional general information sources from the respectives countries.

3.2.1 Case study Denmark

3.2.1.1 Environmental problem

The main environmental problem related to groundwater resources in Denmark is the threat of groundwater pollution stemming from pesticides and fertilizers used in agriculture.[45] For example, in the greater Copenhagen area about 14 million m^3 per year have been lost due to pollution. While this problem already exists for several decades, improvements have been achieved in the near past through the implementation and enforcement of several policy and legal instruments to address in particular the pollution through pesticides and nutrients, such as nitrates and phosphorus.

In view of the impacts of agricultural and urban ecosystems on groundwater bodies, the importance of forests for the quality of groundwater resources has been better understood over the years. It has been recognized that forest cover is beneficial for water protection as the quality of forest waters is generally good. Nevertheless, air pollution and some land management practices may still have negative effects on the groundwater resources. Watershed management must therefore focus more on integrating water and biodiversity concerns.

3.2.1.2 Legal and policy framework in the country

In order to ensure a high groundwater quality for the future drinking water supply, in 1994 the Danish government implemented a 10-point action programme which reasserted the fundamental principle of combating pollution at the source and preventing further pollution of water. The 10-point action programme has since been followed up by concrete action. For many years, research, planning and careful implementation concerning the exploitation and protection of groundwater and water resources have been one of the main activities of the local communities, town planners, municipalities and the federal government. The largest and best reservoirs of groundwater have been designated as protected drinking water areas. Here, particular efforts are made to clean polluted sites and plant

[45] Danish Ministry of the Environment, at http://www.geus.dk/publications/grundvandsovervaagning/grundvandsovervaagning-uk.htm .

forests. Commercial activities must be carried out in such a way that they do not present a threat to the groundwater resources. These areas constitute 35% of Denmark's total acreage.

3.2.1.3 Scheme of payment for ecosystem services

As mentioned above, although they generally provide water of good quality, many of Denmark's groundwater resources are threatened by water pollution. In the last years, this has lead to a situation where two well fields used for water supply had to decrease their levels of groundwater abstraction. One of them is the Solhøj well field where the normal abstraction of about 5 million m^3 per year had to be reduced to only 3 million m^3.

Copenhagen Energy Corporation delivers drinking water to around one million consumers in and around the municipality of Copenhagen. During the last twenty years Copenhagen Energy has lost about 14 million m^3 of groundwater per year. One of the largest groundwater bodies used by Copenhagen Energy is the Vigersted well field from which also ca. 5 million m^3 per year are abstracted. This is equal to the consumption of 100.000 Copenhageners per year. It has therefore been very important for Copenhagen Energy to protect this groundwater body through afforestation measures and the designation of wellhead protection zones where no pesticides are used.

In this context, two forest-groundwater PES schemes have been developed to combat the further pollution of important groundwater bodies. Both PES schemes aim to have two main effects:

- Land-use change from agriculture to forests through afforestation of mainly broadleaf species, and
- In existing forest areas, restrictions on the use of fertilizers or pesticides, and in some cases also underplanting of conifer stands with broadleaf tree species, as the latter increase groundwater recharge.

Just next to the Vigersted well field used by Copenhagen Energy a privately owned forest is located. In order to secure the quality of the groundwater resources found in this area, an agreement has been made between Copenhagen Energy and the owner of the forest. Through this voluntary agreement the private forest owner is now obliged to set aside 95 hectares of his forest where in the future no pesticides may be used. In addition, Copenhagen Energy was able to buy 530 hectares of farm land on which broadleaf trees were planted. Afforestation activities were implemented and managed by the state and local municipalities.

Another example of a PES scheme is based on the state policy to double the country's forest area within a sixty to hundred years time period. In this case, public water companies have entered into a contract with public land owners (the Danish state and local municipalities) who change their forest management practices, or engage in large scale afforestation projects in watershed areas so that they preserve water quality. One such afforestation project has been initiated, for example, in 2001 near Odense, Denmark's third largest city. The Danish Forest and Nature Agency has cooperated with Odense municipality and the local waterworks to establish more than 2.000 hectares of new forest close to Odense. This new forest shall strengthen the recreational possibilities as well as protect the important drinking water resources located in this area.

The time frame of these agreements between the state, the municipalities and the waterworks is 30 years, since groundwater abstraction licenses usually run for the same period of time. As the licenses can be extended, the financial agreements can also be extended. In general, a periodical review of the contracts is carried out every 5 years.

Both PES schemes can be distinguished according to the parties involved. The Copenhagen Energy PES scheme can be characterized as a public-private PES. In this case, the environmental service of improved groundwater quality is provided by a private forest owner who eliminates pesticides in his forest, as well as private farmers who sell their land so that it can be afforested. These private persons are compensated by other private persons, namely the customers of Copenhagen Energy who consume the supplied water, and are the ones who contribute to Copenhagen Energy's fund. Copenhagen Energy again plays only the role as an intermediary in this scheme that collects the money from the clients, and afterwards invests the funds as an incentive for private land owners to change their forest management behaviors or sell their agricultural land.

In contrast, the PES scheme regarding public forests can be characterized as a public-public PES. The main stakeholders here are the private water consumers who pay a levy and thus buy the environmental service of water purification, the Danish state and the local municipalities which provide this service through their public forests, and the water supply companies or waterworks corporations who again play the role as an intermediary working together with the state and the local municipalities in order to develop and implement afforestation plans.

In the case of Copenhagen Energy, a fund has been set up by the water company itself in order to finance the provision of the environmental services. The average consumer pays about 75 kroner (ca. € 10) per year to the fund. For setting aside 95 hectares of private forest, Copenhagen Energy has calculated to pay 10 million kroner (ca. € 1.5 million) in total. The forest owner will be paid on a yearly basis for reducing the use of pesticides. In case of non-compliance with his contract obligations, the forest owner will be fined.

In the scheme between the waterworks company and the state about € 2 million per year is paid to buy agricultural land and start afforestation. The farm land can be bought at around € 10-15 per hectare and afforestation costs may be another € 5.000. For changing the diversity of existing forests, up to € 100 per hectare has been paid to forest owners, depending on the particular contract. In order to fund these activities, based on the Water Supply Act a levy on the water price is charged to the water consumers. The money raised is dedicated to and invested in afforestation projects with the state and municipalities implementing them in public forests.

3.2.2 Case study Austria

3.2.2.1 Environmental problem

The pollution of groundwater as well as surface water resources has been decreased in the course of the last years due to several reasons:

- Determination of emission thresholds for industries and businesses as well as recognition of preventive measures during the planning process of industrial sites;
- Further development and maintenance of the water supply infrastructure and sewage treatment facilities;
- Clean up of hazardous sites as well as stringent regulations for the treatment and disposal of waste;
- Implementation of an environmental program for the agricultural sector.

The groundwater quality is generally considered as satisfactory. 81 % for the monitored nitrate levels are below the threshold of 45 mg/l. However, increased nitrate and pesticide concentrations in certain regions as a result of intensive agricultural activities still pose a challenge for the protection of some of the country's groundwater resources. As a consequence, additional measures have to be taken.

3.2.2.2 Legal and policy framework in the country

In view of these environmental problems, so far a main focus of the legal and policy framework in Austria is to influence the behavior of the agricultural sector in order to reduce its groundwater pollution. As described in chapter 2 above, the Austrian Water Rights Act is the main legal instrument for the protection and sustainable use of the country's water resources. According to the Water Rights Act, groundwater property is tied to land ownership. At the same time it, however, stipulates a profound social attachment of this property right. For each and every withdrawal going beyond private household and economic needs, approval is needed. Obligations to water-pollution abatement are applicable irrespective of property rights.

In addition to the Water Rights Act, a variety of other legal and policy instruments[46] exist which aim at protecting the groundwater resources, such as the Austrian Agri-Environmental Program (ÖPUL) promoting an agriculture compatible with the requirements of the protection of the environment, or the ordinance for rural development (Verordnung "Ländliche Entwicklung"). The Austrian legal and policy framework is guided by the following general principles:

- Prevention instead of rehabilitation

[46] Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft (2003): Nachhaltige Wasserpolitik in Österreich.

- Voluntary instead of mandatory approaches

However, the designation of water sanctuaries and water protection areas according to the Water Rights Act remains the most important instrument to protect the groundwater as well as surface water resources. Such designations limit the rights to use the land within the protected area. The following section describes an example of PES in Austria which is based on this instrument.

3.2.2.3 Scheme of payment for ecosystem services

The Water Association of the Salzburg Basin (Wasserverband Salzburger Becken – WSB) which was founded in 1976 is responsible for supplying its members[47] with drinking water of high quality. Its mandate comprises extracting and disseminating drinking water, developing and maintaining installations, managing its groundwater utility, and securing the water supply in case of emergency.

The drinking water used by the WSB stems from the "Taugl" groundwater body which was made accessible in 2004 through the development of the groundwater utility Taugl. The WSB has obtained a permit to abstract 150 l/s from this groundwater body. The permit is given under the condition that the groundwater model on which it is based will be updated on a yearly basis and takes into account the collected quantitative and qualitative groundwater data. Such groundwater monitoring has to observe the basic geological conditions around the Taugl utility, but also the hydro-geological impacts of upstream and downstream areas. However, a new calculation is only necessary, if extreme events or new groundwater levels have not been reflected in the recent model.

In order to ensure the drinking water supply of the region and consequently the protection of the Taugl groundwater body, a payment for ecosystem services scheme is in place. It is important to understand that the development and implementation of this PES scheme is not based on voluntarism, but mandatory according to the Austrian water law. Its legal basis can be found in § 34 of the Water Rights Act which introduces the legal instrument of declaring water sanctuaries (Wasserschongebiete). § 34 entitles water suppliers to demand the declaration of water sanctuaries, if this is necessary to protect a groundwater body which serves for the general water supply.[48]

After the development of the Taugl groundwater utility in 2004, the State Governor (Landeshauptfrau) of the provincial state of Salzburg was obliged to designate the area around the groundwater utility as a water sanctuary. Based on § 34 Para. 2 of the Water Rights Act, this was done in 2006 through the ordinance for the water sanctuary Taugl (Wasserschongebietsverordnung Taugl). This ordinance replaced a previous ordinance from 1996 (Taugl-Schongebietsverordnung) which already designated a "general" Taugl sanctuary according to § 35 of the Water Rights Act. However, this "general" sanctuary aimed only at protecting the water resources which could ensure the future water supply.

A mandatory PES scheme is therefore created, if

- Due to the designation of the water sanctuary, a land owner is restricted in his rights to use the land; and
- The use of the land that is now limited was legal before the designation took place.

The main stakeholders in this PES scheme are the State Governor (through the Directorate for Agriculture and Forestry) who designates the water sanctuary and thus builds the overall framework for the scheme, the farm and forest land owners who provide the forest ecosystem services, and the customers of the local water suppliers who benefit from the services and in the end fund the compensation payments. The Water Association of the Salzburg Basin and its members serve only as intermediaries who link the respective parties.

[47] Members of the Water Association of the Salzburg Basin comprise the Salzburg Corporation (Salzburg AG) as well as the following communities: Hallein, Bergheim, Elsbethen, Wals-Siezenheim, Obertrum, St. Koloman and Anthering. The Water Association therefore contributes significantly to the water supply of the whole Salzburg region.

[48] F. Oberleitner (2005): Judikatur zum Wasserrechtsgesetz in Leitsatzform: Überblick von 1870 bis einschließlich 2004.

The water sanctuary Taugl is 100 km^2 large and affects around 250 agricultural and forestry enterprises. For these enterprises the prohibition of certain pesticides represents the main use restriction and management difficulty.[49]

Their compensation required by § 7 of the Wasserschongebietsverordnung Taugl, § 34 Para. 4 and § 117 Para. 1 of the Water Rights Act is regulated by a framework agreement between the Directorate for Agriculture and Forestry and the WSB which shall ensure an efficient management of the land owners' claims. The framework agreement was already established in 1999 in order to regulate the compensation under the Taugl-Schongebietsverordnung. Since it has proven its value in practice and has been well received by the affected enterprises, the agreement has been renewed in 2004.[50]

After the replacement of the Taugl-Schongebietsverordnung by the Wasserschongebietsverordnung Taugl, the framework agreement still regulates the compensation of the affected land owners. The agreement remains valid, since the prohibition of pesticides under the previous ordinance which built the main basis for the agreement has been maintained under the current ordinance. From 1999 until 2006, the WSB paid a full amount of € 1.548.750,27 (in average € 193.593,78/a) for the compensation of land owners.[51] The money spent by WSB is collected from its members (the local water suppliers) who again charge their customers.

While the declaration of groundwater sanctuaries is a useful instrument to ensure a high level of protection, it is not always sufficient in areas with intensive industrial or agricultural use. As a consequence, the WSB has developed a system for identifying, monitoring and controlling potential dangers for the groundwater resources. Already in 1991, a cadastre was developed for the entire territory under the responsibility of the WSB. In the meantime, it has been constantly updated due to rapid changes in the agricultural and forestry industries, as well as developments of population density. This cadastre provides the WSB with up to date information on groundwater quality and quantity problems and the potential sources of these problems. As mentioned before, an important category of potential dangers for groundwater resources covers land use for agricultural purposes. The identification and monitoring of all agricultural sites and the different types of agricultural activities helps the water supplier to make a risk analysis. On the basis of this analysis, the WSB can comply with its obligation to develop preventive and protection measures.

3.2.3 Case studies Germany

3.2.3.1 Environmental problem

Germany has plenty of freshwater and can be counted as one of the most water rich countries in the world. As a consequence, on the national scale, the total groundwater quantity is sufficient. However, major variations in the availability of water exist in the individual regions. This is due to the dispersion of the water resources as well as the rate of rainfall within the country which are both very heterogenic. Also, the yield of the groundwater sources and the amount of water required, which is particularly high in urban centers, lead to a situation in many parts of Germany where groundwater resources are overexploited in order to ensure the drinking water supply.[52]

Through intensified groundwater monitoring in the course of the last years it has become obvious that many groundwater bodies are polluted. The greatest threat for the quality of groundwater resources stems from diffuse pollution sources, particularly nitrates, or insecticides from agricultural run-off.[53] In those areas where the need for water is higher than the amount of high quality water available, drinking water has to be purified or delivered through long distance lines.

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[49] See Wasserverband Salzburger Becken (2007): Geschäftsbericht 2006, at http://www.umweltschutzanlagen.at/media/pdf/pdf25.pdf?PHPSESSID=552b5f26059312a7658bed179134e033.
[50] See Anträge des Salzburger Bauernbundes in der Vollversammlung der Kammer für Land- und Forstwirtschaft Salzburg, at http://www.sbg-bauernbund.at/antraege.htm.
[51] See Wasserverband Salzburger Becken (2007): Geschäftsbericht 2006, at http://www.umweltschutzanlagen.at/media/pdf/pdf25.pdf?PHPSESSID=552b5f26059312a7658bed179134e033.
[52] See Federal Ministry of the Environment, Nature Protection and Nuclear Safety, at http://www.bmu.de/gewaesserschutz/fb/grundwasserschutz/doc/3164.php .
[53] Id.

3.2.3.2 Legal and policy framework in the country

Comprehensive legislation on water, forest and nature conservation as well as various programs, guidelines and measures issued by water and forest administrations take groundwater protection into account. In addition to the legal and policy instruments under this framework, e.g. the designation of water protection areas according to the Federal and Provincial States' Water Acts, voluntary measures for protecting the quality and quantity of groundwater resources can be found. In the following section, three voluntary PES schemes will be described. The focus of these PES schemes is the improvement of groundwater quality as well as quantity.

3.2.3.3 Scheme of payment for ecosystem services

a) Lower Saxony

In the German provincial state of Lower Saxony (Niedersachsen), the Water Association of Oldenburg and East-Frisia (OOWV), founded in 1948 as a water and soil board, is the water supplier for an area of approximately 8.000 km^2 and around 1 million clients. Within the supply area for drinking water, the OOWV is running 15 waterworks. The total capacity is 250.000 m^3 per day. The source for the total number of production wells is groundwater only.

Some of the water catchment areas of the OOWV are located in areas of very intensive agricultural land use. The resulting problem of high nitrate concentrations in the wells of the waterworks is already known since the early eighties when quality controls led to the close down of one of OOWV's production wells (the waterworks Holdorf). As a consequence, in 1987 the OOWV started its own groundwater protection programme.

The Water Association's groundwater programme comprises a number of protection measures which include, among others, groundwater-forest PES schemes.[54] The following PES schemes can be found:

- Payments of compensation in water protection areas;
- Payments based on voluntary agreements; and
- Purchase of land for afforestation.

According to § 48 Para 1 of the Water Act of Lower Saxony, water protection areas can be declared in order to protect the quality of water resources which are of interest for the local water supply, as well as to increase the recharge of groundwater bodies. Such water protection areas are declared by ordinance which determine the limitation and prohibition of certain activities in the area, or even introduce requirements for land owners to take certain protection measures. A large share of the water protection areas in Lower Saxony have been established in forests.

Currently the OOWV has 11 water protection areas. In these areas normally

- Conversion of forests to non-forest land use is prohibited;
- Clear-cutting of more than 0.5 hectare requires permission; and
- The use of pesticides is only allowed with special approval.

In general, the German Basic Law (Grundgesetz) considers compliance with these restrictions as part of the social responsibility of private land owners and thus does not give an entitlement for compensation. However, if the limitations, prohibitions or required protection measures exceed the standard of good forest management practice, compensation has to be paid for the economic loss (§ 51a Para 1 of the Water Act). § 51a Para 3 foresees that the beneficiary of the restrictions is obliged to pay. As a consequence, OOWV pays forest land owners in its 11 water protection areas for their restricted forest land use rights.

The restrictions or obligations concerning forest land use which are introduced by the declaration of water protection areas can be even more intensified, if necessary, through voluntary agreements. OOWV has made use of such voluntary agreements several times in the past which foresee:

[54] See OOWV (2004): Realization of Groundwater Protection by the Water Board of Oldenburg and East-Frisia, at www.water4all.com/nations/germany/oowv/Grundwasserschutz/englisch/present._cambridge_chr.aue.pdf .

- Clear-cut free forestry;
- Underplanting of conifer stands with broadleaves (mainly beech);
- Changing from conifers to broadleaves; or
- Application of liming.

Those forest owners participating in these voluntary "additional" activities are paid by OOWV in order to compensate them for their lower yields and therefore lower incomes. The agreements are made between the district administration, OOWV and the forest land owners with additional advice by the Camber of Agriculture.

OOWV has bought more than 2.000 hectares of land in the water supply areas in order to have additional influence on the land use. Around 800 hectares were given to the state forestry administration or the provincial state administration to start afforestation. Around 500 hectares were given to farmers for organic farming and more or less 300 hectares were given to other projects of extensive agriculture or nature conservation. The rest was kept by OOWV as reserve for later afforestation or for changing areas near the wells.[55]

The situation in Lower Saxony with a legal framework for groundwater-forest PES has lead to a concentrated cooperation between several stakeholders: Forest owners who provide ecosystem services, water consumers who provide funding through their payments of a water abstraction charge, and the water association OOWV, the Chamber of Agriculture as well as the provincial state government, mainly the district administrations, as intermediaries.

Stakeholders regularly meet in Round Table Meetings (established by the Water Act) in order to discuss problems and possible solutions. Every year the district administration invites all participants to the annual cooperation meeting to discuss about measures, results and compensation payments. A conflict resolution exists within the Chamber of Agriculture.

In order to finance the OOWV's groundwater protection measures (as well as other measures promoting sustainable land use in water catchment areas), § 47 of the Water Act of Lower Saxony introduces a water abstraction charge. According to § 47a, depending on the purpose of the water abstraction different amounts are charged. While the private user has to pay 5 cent/m^3, industrial and agricultural users are charged much lower. In the year 2003, the OOWV transferred a total amount of around € 3,78 million stemming from this water abstraction charge to the provincial state government of Lower Saxony.[56] § 47 h determines that 40 % of the resulting income is spent to fund measures for groundwater protection and sustainable land use. Part of the water abstraction charge is therefore paid back to OOWV to compensate for economic loss in water protection areas and to fund voluntary agreements or purchase forest land.

The groundwater-forest PES scheme in Lower Saxony has proven to be effective, since improved groundwater quality has been monitored in cases where sufficient forest cover has been established in the area. Since water providers such as OOWV certainly evaluate the efficiency of their payments, the PES scheme can also be considered as cost-effective. However, the scheme has not yet achieved general acceptance by other water companies as well as forest owners. The participation of water companies like OOWV is still limited, since most companies regard normal forest management according to the Forest Act as sufficient to fulfil their expectations concerning groundwater quality. Forest owners again claim also payments for the mere existence of their forests, i.e. independently from special management activities, which is not yet funded under the PES scheme.

b) Bionade

Another case study example is related to the Bionade Corporation. Bionade is a young, innovative and privately owned German company established in 1995 and situated in the Bavarian section of the Biosphere Reserve "Hohe Rhoen".[57] Bionade Corporation is producing and distributing organically manufactured non-alcoholic refreshment drinks under the Bionade trademark. Bionade was and still is the world's first non-alcoholic organically produced

[55] Id.
[56] See OOWV (2004): Realization of Groundwater Protection by the Water Board of Oldenburg and East-Frisia, at www.water4all.com/nations/germany/oowv/Grundwasserschutz/englisch/present._cambridge_chr.aue.pdf .
[57] See www.bionade.de .

refreshment drink. It is produced through a completely organic fermentation process borrowing from age-old brewing techniques and complying with the so called German Purity Law (Deutsches Reinheitsgebot).

In this context, Bionade Corporation supports organic farming in the structurally weak Rhoen region. In autumn 2005, the company started its collaboration with the first organic farmers in the region in order to respond to an ever-increasing market demand for Bionade and to assure a permanent supply of locally grown organic raw materials for their product.[58] Bionade Corporation guarantees participating farmers who convert their operations into organic farms up to a 100% purchase of their organic barley and elderberry harvests. All of the organic raw materials not only conform to the current EC regulation on organic farming (Regulation EEC N° 2092/91) but also to the substantially stricter guidelines of German associations of organic farmers, such as those of Naturland e.V.

In addition to the generation of organic raw materials, Bionade Corporation is also highly interested in the quality and quantity of drinking water, the main ingredient of Bionade. In April 2008, Bionade Corporation has therefore gone even a step further than supporting organic farming by starting a project together with Trinkwasserwald e.V. (Drinking Water Forest Association) for the sustainable regeneration of the resource drinking water.

The partnership between Bionade and Trinkwasserwald e.V. aims to create over 130 hectares of so called "drinking water forests" throughout Germany in the next years. Such drinking water forests require the conversion of conifer monoculture forests to deciduous broadleaved forests.[59] Trinkwasserwald e.V. has calculated that 10 years after a forest has been changed accordingly, it provides for 800.000 litres additional available groundwater per hectare and year in the annual average. Through its financial support of Trinkwasserwald e.V., Bionade Corporation is planning to generate in a sustainable way 100 million liters additional ground- and drinking water. This action shall compensate for the total amount of drinking water used in the Bionade product each year.

Trinkwasserwald e.V. is in charge of organizing the process of creating new drinking water forests together with public or private forest owners. In this context private contracts are signed between Trinkwasserwald e.V. and the public or private forest land owners for a period of 20 years. In order to participate in this PES project, forest owners have to agree to dedicate at least 18 hectares of their forest land to the conversion process. On the dedicated sites, conifer forests are then thinned and harvested earlier than usual. Afterwards, they are replaced by deciduous broadleaved tree species.

In the case of the Bionade Corporation, in order to increase the level of groundwater re-charge (quantity) as well as to prevent pollutants, such as fertilizers, insecticides, etc., from entering into groundwater bodies (quality), Bionade has entered into a partnership with Trinkwasserwald e.V. (and will be in active cooperation with additional regional partners). Trinkwasserwald e.V. is an environmental NGO founded and registered in Germany in 1995. Its goal is to promote the public ecological awareness about the importance of forests in the context of air, soils and water, and to save current and future generations' quality of life by securing and reproducing drinking water.[60] In order to achieve this goal, Trinkwasserwald e.V. encourages a close cooperation between policy makers, the private sector and other environmental NGOs. Within this framework, Trinkwasserwald e.V. sees itself as an intermediary. Together with its partners it aims to actively change pure coniferous forests into drinking water forests by underplanting them with deciduous trees – primarily in areas of drinking water abstraction.

The main stakeholders involved in the Bionade PES scheme are as follows:

- The private soft drink company Bionade Corporation as the payer for the environmental service;
- The NGO Trinkwasser e.V. as the intermediary of the PES scheme; and
- The public and private forest owners as the service providers.

Bionade Corporation covers all costs arising during the process of converting the forest land from conifers to broadleaves. Such conversion requires financial resources for ground preparation, nursery stock, planting and fencing. Trinkwasser e.V. has calculated that the actual expenditure for converting one hectare of conifer monoculture into drinking water forest, and thus the generation of 800.000 l/year will cost one-time € 6.800 per

[58] See www.bionade.com/bionade.php/10_de/10_unternehmen/01_biolandbau?usid=484cecc0b6296484cecc0b6a5a .
[59] See S. Rust: "Waldstruktur und Wasserhaushalt".
[60] See www.trinkwasserwald.de .

hectare, including possible re-plantings, maintenance of the cultures etc.[61] The payments by Trinkwasserwald e.V. to the forest land owners are made as the actual costs occur.

c) Kaufering

Bavaria forms the southernmost and geographically largest state of Germany. One third of Bavaria is covered with forests and with more than 2,5 million hectares of forests it is the German state with the highest density of forests. One third of the forests, serve as drinking water protection area or so-called water protection forest.

Kaufering, is a municipality with 9780 inhabitants located in the district of Landsberg in Bavaria, where high nitrate pressures on groundwater exist due to intensive agricultural practices. Recent research in the area itself, but also in general (Kreutzer, Rehfuss, 1982/83) has reaffirmed that in deep loam soils under pure spruce (*Picea abies*) stands, the nitrate concentration is significantly higher than under mixed forests with beech (*Fagus sylvatica*). The lowest nitrate concentration was measured under pure beech stands. These research results were used to lay the foundation for developing a system for payment for ecosystem services in relation to the forest function of water purification.

Article 14 Para.2 of the German Basic Law (Grundgesetz) spells out that property also means duties and that the use of the property should benefit the public. However, while Article 14 restricts the use of property in the interest of the public (e.g., the protection of drinking water resources), any such restriction needs to be compensated, if it exceeds an "acceptable" level and thus qualifies as expropriation, Article 14 Para.3.

Rather than engaging in de facto expropriation and compensation of land owners, the municipality of Kaufering in cooperation with the Office for Agriculture and Forestry in Fuerstenfeldbruck/district Kaufering has decided to go a different way in order to achieve a better status of its groundwater resources. In line with § 1 of the Decree regulating the compensation according to Art. 36 a Para 2 of the Bavarian Nature Protection Act (Verordnung über Ausgleichszahlungen nach Art. 36 a Abs. 2 Bayerisches Naturschutzgesetz), the municipal waterworks of Kaufering have concluded voluntary agreements with private forest owners to "compensate" for economic disadvantages suffered by the owners when adhering to the obligations under the agreements.

According to the agreements, forest owners in the municipality of Kaufering receive a yearly payment of € 200-300 per hectare for the transformation of coniferous forests in deciduous forests. However, a requirement for participation in the compensation scheme is that the owner has forests located in the designated water protection area.

The higher costs of forest management spanning from the prescriptions of the agreement are based on

- the higher percentage of deciduous species,
- continuous forest cover structures,
- the ban on creating larger felling areas, and
- the limitation of the mode of utilization such as operating without pesticides and fertilizers in case of energy forests.

The details of the payments are as follows:

1. At the planting of a water protection forest a onetime payment of € 250 is made.
2. In addition, yearly payments are made of
   a) up to € 230/hectare for a forest consisting of 95% of broadleaf species and of 5 % spruce (*Picea abies*), or
   b) up to € 275/hectare for 100% broadleaf forest.
3. For an energy forest (afforested agricultural area) a onetime payment of € 650 is made for its planting.
4. In addition, yearly payments of € 230/ha are made for an energy forest.

The incentive is paid by the waterworks directly to the forest owners. The waterworks themselves charge the water users by increasing the water bill accordingly.

[61] See Trinkwasserwald e.V., at http://www.trinkwasserwald.de/english/index.html .

Payment is related to the achievements in relation to the composition of tree species and type of forest management. There is a control system in place, in the framework of forest protection measures every 4-10 years. At the start the status and required protection is determined and based on that the incentive amount is determined and improvements become measurable.

The following stakeholders have an interest in the scheme:

- Water works: interested in water quality improvement
- Forest owners: strong interest in the stability of their forests through protection and increase in income
- Municipality: security of water supply for citizens
- Drinking water consumers: drinking water quality is important, awareness about it can be improved
- Farmers: competitors for land-use as the available land is limited

The incentive scheme cannot yet economically compete with agricultural land use, which is more profitable as a result of European, federal (German) and regional (Bavarian) subsidies. One could say that these subsidies "block" the increase of forests in the water protection area. While it is not the full cost of drinking water, which is paid to the forest owners, it is at least an incentive, which motivates forest owners to manage their forests in a certain way, which is beneficial for the water supply, both in terms of quantity and quality. For good quality drinking water, a higher price should become more and more acceptable.

Research has already shown the relation between water quantity and quality and the protection of the forest. However, further data is necessary to develop management practices for the forest, which capture economic interests, but also minimise the risks for groundwater resources in the long run. Climate change raises new questions in this respect and monitoring of impacts has to facilitate the development of adaptation strategies. Other important aspects to take into account are the water use of different tree species and the water use in the forest in relation to the selection of the tree composition for ensuring future drinking water supply.

3.2.4 Case study Spain

3.2.4.1 Environmental problem

Groundwater in Spain, as in other arid or semi-arid countries worldwide, has been intensively used for the expansion of irrigated agriculture due to its easy access, low cost of irrigation infrastructure and high farming profitability [62]. While the groundwater pumping for irrigated lands has helped to achieve economic benefits for agriculture since the early 70s, it has also imposed stress on groundwater systems and lead to far-reaching environmental and social problems. The largely uncontrolled use of groundwater resources has resulted in the overexploitation of aquifers, environmental degradation and loss of associated valuable wetlands and aquatic ecosystems.

A remarkable example for such overexploitation can be found in the Spanish southern central plateau in the Guadiana river basin. This river basin has an extension of approximately 18.900 km^2 along the Spanish autonomous communities of Andalucía, Castilla la Mancha and Extremadura. Specifically in the upstream part of the basin (from now on Alto Guadiana) 6 important aquifers have been identified. One of them is the Western La Mancha Aquifer. Overpumping by irrigators in the Western La Mancha Aquifer has resulted in economic and environmental negative externalities such us the following:

- Global diminution of the water table and intensification of control measures
- Increased extraction costs
- Loss of property rights due to drying-up of wells when the water table falls
- Increase in crop production and agricultural supply which drive decrease in crop prices
- Pollution and degradation of the associated wetlands of the national park "Tablas de Daimiel", an internationally acknowledged, and Ramsar-nominated aquatic ecosystem of high ecological value.

[62] Llamas M.R. (2005): Lecciones aprendidas entres décadas de gestión de las aguas subterráneas en España y su relación con los ecosistemas acuáticos. González-Bernaldez Lectura 2005. Universidad Autónoma de Madrid, Spain, 66 p.

3.2.4.2 Legal and policy framework in the country

Two main public policy bodies affect directly and indirectly groundwater consumption in the Alto Guadiana, as well as water policies and agricultural policies. In order to solve the ecological problem of groundwater overexploitation, the River Basin Authority (RBA) adopted a Water Abstraction Plan (WAP) in 1991 which imposed a strict water quota regime with no compensation to farmers for their derived income loss. However, the quotas which reduced considerably the entitled historical water rights of the irrigators and could not be enforced due to the large social costs implications. In 2003, the EU Agri-Environmental Programme policy and the national WAP were coupled for the first time under a common objective of recovering the Western La Mancha aquifer. But since the compensation payments were barely covering farm income loss from less water being available for farming, the program was rejected by a large proportion of the farmers.[63]

According to the Law N. 10/2001, the RBA has now prepared a Special Plan for the Upper Guadiana (SPUG) which was recently approved by the Spanish parliament through the Royal Decree 13/2008 of the 11th of January of 2008. The SPUG includes different types of measures, such as

- Purchasing water rights from the irrigators,
- A social restructuring plan that includes the legalization of illegal wells and the closing-up of un-licensed bores,
- A reforestation plan, and
- The support of extensive rainfed farming.

3.2.4.3 Scheme of payment for ecosystem services

A forest-groundwater PES scheme has been developed through the Sub Programme of Reforestation under the SPUG. Like the other sub programmes under the SPUG, the reforestation programme aims at recharging the overexploited aquifers by 2027. Other objectives of the scheme include:

- Restoration of aquatic flora & fauna, and biodiversity;
- Reduction of climate change effects; but also
- Developing and stabilizing the forest sector as an alternative to traditional agriculture;
- Enhancing conditions to increase tourism in the mid- to long term; and
- Enhancing the creation of new industries linked to the forestry sector.

Under the PES scheme, payments for reforestation of agricultural lands are foreseen which shall provide funding:

- In the phase of reforestation/planting
- To maintain the planted forest
- To compensate for lost income

The payments for the reforestation/plantation of trees in the first year will be subject to the fulfilment of technical, sanitary and density (minimal woodland by hectare) requirements for the different tree species. The financial support to cover the maintenance costs consists of an annual support calculated per hectare of agricultural land that has been reforested. These payments will be granted up to a maximum period of 5 years. The compensation payments are made on an annual basis for a maximum period of 20 years. Both, payments for maintenance and compensation can only be made after the correct execution of the reforestation has been certified.

Regarding the reforestation process three possible ways have to be distinguished:

- Reforestation executed by the RBA

[63] Consuelo Varela-Ortega, Chris Swartz, Tom Downing and Irene Blanco (2008): Water Policies and Agricultural Policies: An Integration Challenge for Agricultural Development and Nature Conservation, at http://wwc2008.msem.univ-montp2.fr/resource/authors/abs430_article.pdf .

In this case, the reforestation and maintenance of the forest will be undertaken by the RBA itself. The land owner only receives the compensation payments. This has the advantage that the correct execution of the plantation and maintenance works as well as the correct use of the financial resources is ensured, and less control is needed.

- Reforestation executed by the private land owners

In this case, the plantation of trees and their maintenance will be undertaken by the private land owner with support from the RBA. In addition, the land owner receives the compensatory payments for a maximum of 20 years. This has the advantage that the RBA is less occupied with planning and implementation work. However, it also means a greater danger of misuse of the financial support and a need for more control of the land owners' activities.

- Acquisition of the areas on behalf of the RBA

Finally, the RBA can also directly buy the land in order to carry out the reforestation and maintenance works. This has the advantage that future land use changes are rather unlikely, since the major investment for the acquisition of land provides an incentive for the maintenance of the reforestation for life.

The total budget for the implementation of the reforestation activities from 2008-2027 is estimated to be € 1.185.000.000.[64] However, since the SPUG and the reforestation programme have only been adopted in early 2008, the implementation of some of its main elements, including the PES scheme, is still under development. Therefore, it is too early to judge the effectiveness and efficiency of this PES scheme.

3.3 Comparison between case studies

In this chapter, the current state of the art with regards to the development of forest-groundwater related PES schemes has been explored. The examples given above, demonstrate that PES structures exist in EU member states which fund afforestation and sustainable forest management practices and thus support, maintain or even develop the protective functions of forests with regards to groundwater. Also, the described cases prove that PES can be a valuable instrument for increasing the interest of land and forest owners in developing these forest functions. However, as has also been shown, forest-groundwater PES schemes are not in place in most countries of the EU. The future development of such mechanisms can benefit from the experiences of the existing examples.

Therefore, in this section, the case studies described will be compared to determine which differences there are in the structure of PES in relation to groundwater and forests. Here we will look at whether the transaction is voluntary or not, who the sellers and buyers are and if this leads to protection of the ecosystem service.

In Denmark supporting policies that strengthen afforestation efforts and sustainable forest management for the protection of groundwater exist. However, these are mainly focused on publicly owned forests while the majority of forest land in the country is privately owned. In addition, voluntary public-private and public-public arrangements have been established which are mainly funded by the private water consumers who pay more on their water bills. With these funds, water companies invest in afforestation and sustainable forest management by buying land or by paying private forest owners to ensure the required practices on a voluntary basis.

In Austria, legal protection and sustainable use of the country's resources is secured by the Water Rights Act and the Austrian Agri-Environmental Programme. The protection of the area around groundwater resources which are used for public water supply is ensured by the declaration of water protection sanctuaries. Such declarations introduce mandatory arrangements between the water suppliers and forest owners who face restrictions regarding their allowed forest management practices. Just as in the Danish case, the funds to compensate the land owners in the sanctuaries are provided by the water suppliers which collect again the money from their consumers.

In Germany, half of the country's forests are owned by the state and just like in the two other countries, groundwater sources are overexploited and threatened by pollution. At the provincial state level, groundwater legislation exists which, just like in Austria, foresees groundwater protection through the designation of water protection areas on the one hand, and compensation payments for negatively affected forest land owners on the other hand. These mandatory PES schemes are combined with voluntary agreements which are based on

[64] See, Plan Especial del Alto Guadiana, at http://www.chguadiana.es/corps/chguadiana/data/resources/file/PEAG/8_PRESUPUESTO.pdf .

groundwater protection programmes, like in the case of Denmark. The necessary funds are at least partly collected from private consumers, as in Austria and Denmark.

In the Spanish case, the overexploitation of groundwater resources through irrigation agriculture does not only threaten the country's water supply and natural heritage (such as the national park "Tablas de Daimiel"), but also the sustainability of the agri-economy. Like in Denmark, supporting policies aim at strengthening reforestation efforts which shall protect the groundwater resources. However, in contrast to the Danish case, the PES scheme is focused on private agricultural lands and not public land.

The next table will provide an overview of the main elements of the PES schemes developed in the different countries described in the case studies.

Table 7: Comparison between case studies on key PES elements

Country	Stakeholders	Type of PES scheme	Phase of development	Payment structure + time frame
Denmark	Public waterworks, private forest owners and the state and local municipalities, water consumers	1. Voluntary agreement between a private forest owner and the water works to set aside forest land where no pesticides are used 2. Voluntary afforestation of farmland bought by the waterworks and managed by the state and local municipalities 3. Voluntary agreement between public water companies and the state and local municipalities on afforestation of public forest land and change of forest management practices	Public-private agreement started after 2000 Agreement between the water works and the state + municipalities in 2001 in Odense.	1. Funds for compensation to the private forest owner on a yearly basis obtained through payments by water owners. Total fund for setting aside 95 hectares is € 1,5 mln 2. Between state, municipalities and waterworks: € 2 mln/year for buying agricultural land for afforestation. For changing forest management practices payment of up to € 100 per hectare per year are paid to forest owners. Agreements of 30 years with a periodic review every 5 years
Austria	Water Association, State Governor, farm and forest land owners, water consumers	Mandatory scheme according to Austrian Water legislation, where land owners are compensated for prohibition of use of certain pesticides	The scheme started in 1999,	From 1999 until 2006 a total amount of € 1.548.750,27 was paid to 250 land owners. The funds were obtained by the local water suppliers who charge the consumers
Germany				
a) Lower Saxony	Water Association, forest owners	1. Payments of compensation in water protection areas 2. Voluntary agreements between forest owners and the water association	Since 1987, the water association started a water protection programme	1. Compensation for compliance with water protection requirements paid from a water abstraction charge 2. Payment to forest owners for additional forest protection activities 3. The water association has bought 2000 hectares of land

		3. Purchase of land for afforestation		in water supply areas for afforestation, organic farming and extensive agriculture or nature conservation purposes.
b) Bionade	Drinking water forest association, soft drinks company, forest land owners	Voluntary agreement between a private company and an environmental NGO	In 2008, the project started with the drinking water forest association and Bionade	Payment to transform coniferous forests to broadleaf forests for a price of € 6800 per hectare to be paid by the NGO to forest owners when actual costs occur
c) Kaufering	Private forest owners, the municipal waterworks, Office for Agriculture and Forestry, drinking water consumers	Voluntary agreement between the municipality and forest owners in a water protection area		Incentive scheme, where forest owners are paid 200-300 hectares per year for forest management practices contributing to the quality of drinking water supply. Funds are obtained from the drinking water price
Spain	Private forest owners, the River Basin Authority	Voluntary agreement between the River Basin Authority and private (agricultural) land owners	Policy establishing the PES scheme has been developed at the beginning of 2008	Possible payments for • reforestation/planting over 1 year • maintenance of planted forest over 5 years • compensation for lost income over 20 years Payments from 2008-2027 are estimated to be € 1.185.000.000.

In all the case studies, the effectiveness of the described PES schemes is without question. Only in the case of Spain it is too preliminary to draw a conclusion. A key reason for the effectiveness of the schemes is that the links between the forest ecosystems, forest management practices and groundwater resources management are well understood.

The case studies show that PES schemes can comprise diverse structures which have to be distinguished. They can range from voluntary compensation to non-voluntary compensation schemes for forest maintenance, afforestation, reforestation and sometimes agro-environmental activities. The future development of purely voluntary compensation schemes which are initiated by the private sector, such as in the special case of Bionade, can hardly be directly influenced. The only indirect way to promote such private initiatives is through the funding and implementation of research projects which lead to increased scientific certainty and clarity with regard to the forest-groundwater relations. The much higher number of PES schemes related to agriculture and water might be a valuable indicator for this linkage between the development of PES and scientific knowledge. The impacts of agricultural practices on the quality of groundwater resources, thus the ecological problems are already well understood for a longer period of time, while the knowledge about so called “drinking water forests” only starts to become widespread.

In contrast, public-private and public-public PES schemes, such as the ones established in Spain, Austria, Germany and Denmark, can be considered as a “mixture” of voluntary and compulsory arrangements. These PES schemes are most likely to be replicable in other EU member states. As shown in chapter 2, in all EU member

states, the legal and policy frameworks related to forest and groundwater already recognise the role of forest ecosystems in water management. As a consequence, a strong argument and legal basis for the introduction or further development of afforestation policies and programmes, comparable to the programmes in Denmark and Germany, is built. Also, the groundwater and forest legislations of all EU member states offer clear opportunities for the introduction of PES instruments which are similar to those of the four countries. It is important to note that in the case of Austria and Germany, the designation of groundwater protection zones has been a key step in the development of the PES schemes. Such designations have triggered compulsory PES through the compensation payments foreseen by the countries' respective laws. The same strategy can be followed by other EU member states.

In order to "copy" PES schemes like in Spain, Austria, Denmark or Germany, additional financial resources have to be collected as well. Again, as shown in chapter 2 above, the groundwater related compensation structures in EU member states provide opportunities for raising such funds. However, this requires a serious effort to cover the full costs of water supply, including environmental costs such as the ones linked to PES projects.

3.4 Envisioned PES schemes

Respondents referred to a few projects that might develop into future PES schemes related to groundwater and forest in the EU:

Maramures, WWF Danube, Carpathian Programme, Romania

This project is part of the WWF International ONE EUROPE MORE NATURE initiative and aims to catalyse farmers, consumers, forest owners/managers, businesses and policy-makers to re-create living river basins so that new farming practices as well as other ways of sustenance ensure biodiversity and ecological functioning in Europe's changing landscapes.

In order to implement its ONE EUROPE MORE NATURE initiative, WWF is identifying mechanisms – market and/or policy mechanisms - which will ensure the sustainable management of the interlinked habitats.

At Nistru, near Baia Mare, a local investor and the local authorities, together with WWF, are in the process of improving catchment management. Funding may come from a simple PES mechanism. A local bottled water company is eager to market its product as high quality, pure water from a natural catchment. In return for the right to do so, it will give a percentage of its profits to the local council for improved management of the area upstream of the source.

- This proposed PES scheme would be a private-public scheme which combines direct payments to forest owners and setting up a trust fund for asset building and further management improvements.

The WWF PES initiative in Maramures, which is the county where Baia Mare is located in Romania, is yet only in an early stage of implementation. The current work is focusing on the valuation of ecosystem services delivered by forests. A feasibility study for a PES scheme will be conducted in the coming months based on the baseline information of forest ecosystem services valuation. Scenarios development for possible scheme configurations and related costs will be considered. It is estimated that the process of setting up the scheme and negotiating with the various partners could start already during 2008. However, this will depend on the results of the studies which need to show positive figures and prove the real feasibility of a PES scheme.

The City of Munich, Germany

The City of Munich has been extracting its potable water from three catchment areas: from the valley of river Mangfall for more than 125 years, from the so-called Munich gravel plain, and, since 1983, from the upper valley of river Loisach. The land in the catchment areas is mainly used for farming purposes.

In the future, it is planned to subsidize ecological farming in the conversion area, as well as to purchase all possible land in order to do further afforestation. However, it should be noted that so far, SWM does not pay private forest owners for natural forest cultivation. Also, the forest land which is already sustainably cultivated had been bought by the city of Munich at an earlier stage. As a consequence, the payments for this land and its services do not qualify as PES.

The Ardennes Meuse project, Belgium

This project initiated by WWF Belgium and various national and local environmental organisations (again under the ONE EUROPE MORE NATURE initiative) is trying to reduce flood risk by converting land back into wetlands which act as natural sponges. The aim is to increase water retention capacity and hold back the floodwaters. Since there is a clear link between water retention at the source, impacting on both surface and groundwater, and forest management in the area, the latter could be a crucial part of the project.

Although a PES component is not yet developed as such in the project, it is hoped that initial funding for the farmers to implement the scheme could come from the Common Agricultural Policy's Rural Development Fund, which supports the implementation of key EU water and nature protection legislation. Thus the farmers of the Ardennes would become water managers and not just food producers.

Parcs Naturels Hydrogéologiques, France

In France, the idea of creating large scale hydro-forestry natural parks is being promoted by different scientists.[65] The aim and main function of such hydro-forestry natural parks would be the reduction of all pollution and thus the production of drinking water. The idea would require in practice that protected water basins are declared where only such activities are allowed that do not hinder the provision of water purification related ecosystem services. Since the water would be primarily used as drinking water for the local communities of the surrounding areas, these could have an interest in funding the parks. However, it has to be shown that the use of the basins for the production of untreated drinking water is economically cost efficient and can compete with other intensive uses of the area. It is assumed that especially mountain areas and areas that are less fertile for agriculture could be the ones eligible for the creation of such natural parks.

4 Analysis of options for management practices influencing water quantity and quality based on PES

4.1 Introduction

Forest and water managers seem to be destined to collaborate more closely together when looking at the role that forests can play in providing filtration and storage for the water supply. Deforestation, fragmentation and pollution can lead to a reduction of water yield and quality. To determine the key elements in relation to ecosystem services of groundwater in European forests it is important to understand the relationship between ground water resources and the impact of forest management practices.

However, the influence of forest management on the hydrology and hydrochemistry of catchments remains unclear: different studies often show contradictory impacts at various stages of the forest cycle in contrasting environmental settings, even within the temperate zone [66]. Furthermore, identification of the impacts of forestry can be confounded by other factors such as climatic variability and longer-term aspects of environmental change. These complications are exacerbated by a lack of long-term data sets to assess the relative importance of different drivers of hydrological and hydrochemical change [67]. In the following sections, an overview of scientific literature is presented, covering both quantitative and qualitative relationships between forest and forest management on the one hand, and water (availability and quality) on the other hand. The paragraphs on quantitative and qualitative aspects are followed by a discussion on the effects of afforestation and plantation forestry on water availability and quality, as this topic has come under heavy scientific and political debate in recent years. This chapter will conclude with a summary of ongoing and planned research cooperation in the field of forest management and water relationships and an overview of best practices in the combined effort of managing forests and water. However, we start this chapter with an introduction to water fluxes and infiltration processes.

[65] See for example Prof. G. de Marsily.
[66] D. Tetzlaff, I.A. Malcolm, C. Soulsby (2007): Influence of forestry, environmental change and climatic variability on the hydrology, hydrochemistry and residence times of upland catchments. *Journal of Hydrology 346,* 93-111.
[67] J.S.G. McCulloch (2007): All our yesterdays: a hydrological retrospective. Hydrology and Earth System. *Sciences 11,* 3–11.

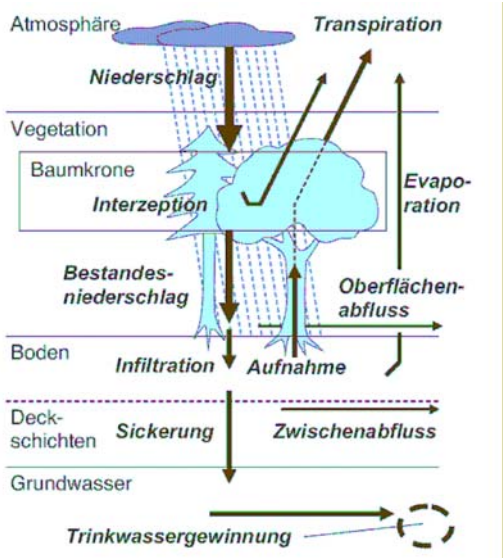
4.2 Water flux and infiltration processes

In forests, many water and substances fluxes influence the quantity and the quality of the water that infiltrates in the soil. The main water fluxes going through the compartments of this system are described in Figure 1. Vegetation – mostly leaves and needles from trees – intercepts precipitation. Interception varies from 15 to 33 % for broadleaved trees, from 20 to more than 50 % for conifers (Aussenac and Boulangeat 1980[68]). The season also influences interception. This water can then:

- go to the soil like through fall or by stem flow,
- or go back in the atmosphere by evaporation.

Water storage in the soil depends on the type of the soil (depth, nature, porosity). The type of vegetation influences the water quantity which will be taken by the roots or directly evaporated in the atmosphere on the soil surface (shadow, litter layer). The part of water that is not stored in the soil, or not absorbed by the roots, infiltrates in the aquifer water through superficial soil layers.

Figure 5: Water fluxes



Atmosphäre	atmosphere
Niederschlag	precipitation
Baumkrone	canopy
Interzeption	interception
Bestandesniederschlag	through fall
Oberflächenabfluss	surface runoff
Boden	soil
Aufnahme	uptake
Deckschichten	superficial horizons
Sickerung	percolation
Zwischenabfluss	hypodermic flow
Grundwasser	water table
Trinkwassergewinnung	drinking water catchment

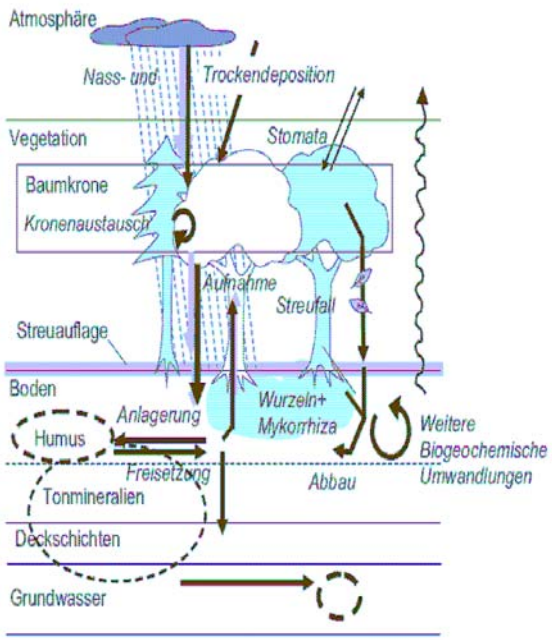
Source: Hegg et al. 2004[69]

Water coming from several small watersheds infiltrates in the same aquifer water. The transport duration and mixing/transformation processes depend on the type and characteristics of the aquifer (unconsolidated materials, fault, karst). Figure 2 represents the main substance fluxes determining components concentration in water. Snow and rain contain components from aerosols and gases (humid deposition). Dust and particles also accumulate on vegetation (dry deposition). Leaves and needles act like a filter to catch these depositions, but the quantity of intercepted pollutants depend a lot on tree architecture. Water that evaporates on leaves is pure, therefore the concentration of the deposited components increases in the water that remains on the tree and reaches the soil. This process is called the purification effect of tree crown.

[68] Aussenac, G. & Boulangeat, C. 1980. Interception des précipitations et évapotranspiration réelle dans des peuplements de feuillus (Fagus sylvatica L.) et résineux (Pseudotsuga menziesii (Mirb.) Franco). Ann. Sci. Forest., 37(2): 91-107.

[69] HEGG (C.) et al. (2006). La forêt et l'eau potable : une étude bibliographique. - Institut fédéral de recherches sur la forêt, la neige et le paysage, WSL.

Figure 6: Substances fluxes



Atmosphäre	atmosphere
Nass- und Trockendeposition	dry and humid deposition
Baumkrone	canopy
Kronenaustausch	exchanges between tree crowns
Aufnahme	uptake
Streufall	leave fall
Streuauflage	litter layer
Anlagerung	deposition
Freisetzung	releasing
Wurzeln+Mykorrhiza	roots and mychorriza
Abbau	decomposition
Weitere Biogeochemische Umwandlungen	other biogeochemical modifications
Tonmineralien	clay minerals
Deckschichten	superficial horizons
Grundwasser	water table

Source: Hegg et al. 2004

Forest soil also purifies water. In the underground water of a forest soil, substance concentrations are modified by different processes:

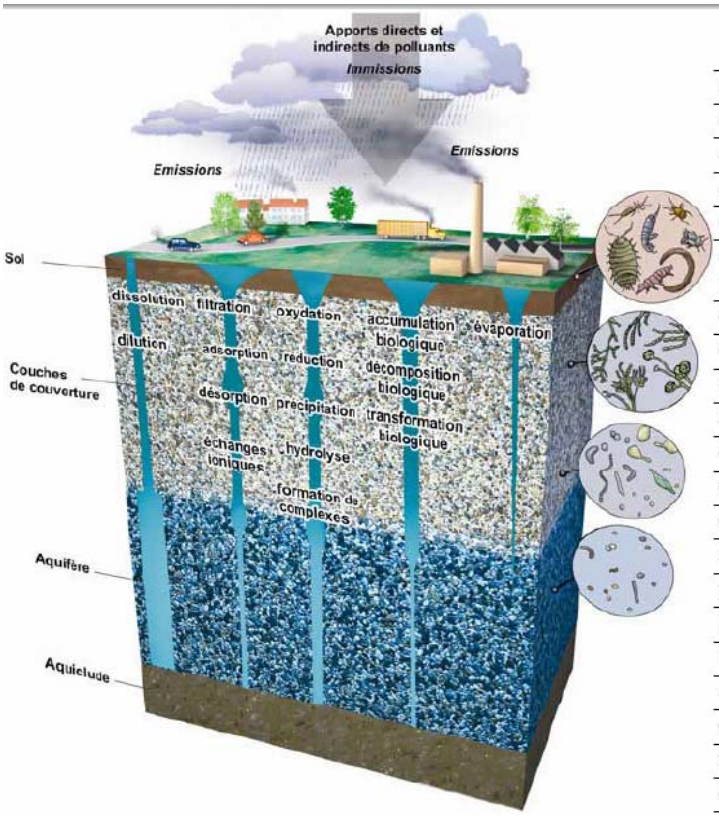
- deposition on humus and clay minerals (ions exchanges),
- uptake of substances by roots,
- fixation in biomass and other biogeochemical transformations.

These transformations are influenced by pH values and oxygen quantity (redox reactions). Biogeochemical transformations can also solubilise solid substances present in the soil or biomass, this is the process called mobilisation.

Auto-purification phenomena that occur in soils, mainly in horizons A and B, have a very important impact on water quality (Fig. 3). Solid particles are filtered and dissolved particles are adsorbed or transformed by biochemical phenomena. Adsorption takes place mainly on clay, oxides and humic substances.

A big part of the pollutants present in infiltration water is retained and degraded in the superficial part of the soil. Auto-purification phenomena decrease in the non saturated zone of the soil. And in the saturated zone, dissolved substances are transported rather quickly on huge distances with underground water; the decrease of the concentration of these pollutants is then mainly realised by dilution.

Figure 7: Elimination of pollutants in soil and underground



sol	soil
couches de couverture	superficial layers
aquifère	aquifer
aquiclude	impermeable rock
emissions	emissions
apports indirects de polluants	indirect input of pollutants
dissolution	dissolution
dilution	dilution
filtration	filtration
adsorption	adsorption
désorption	desorption
échanges ioniques	inonic exchanges
oxydation	oxydation
réduction	reduction
précipitation	precipitation
hydrolyse	hydrolyse
formation de complexes	complex formation
accumulation biologique	biologic accumulation
décomposition biologique	biologic degradation
transformation biologique	biologic transformation
évaporation	Evaporation

The column width variation corresponds to the relative efficiency of purification phenomena during water infiltration[70].

Several factors have to be taken into account to determine underground water vulnerability for a particular soil. The DRASTIC method is a well known method used by hydro-geologists. Its main principles are described below.

This method relies on 3 hypotheses:
- Potential pollution sources occur at the soil surface ;
- Potential pollutants go from the soil surface to the aquifer through infiltration ;
- The nature of potential pollutants is not taken into account.

The seven letters of DRASTIC represent the seven factors determining the vulnerability index.
These factors are:
- D : depth of water table (5) ;
- R : recharge or infiltration (4);
- A : aquifer media (3) ;
- S : soil media (2) ;
- T : topography (1) ;
- I : impact of vadose zone (volume of soil from 1 meter depth to the water table) (5) ;
- C : conductivity (3).

A weight is associated to each factor (coefficient from 1 to 5 corresponding to the figure given into brackets after each factor just above). The most important factors are the water table depth and the impact of vadose zone, then infiltration, then aquifer media and conductivity, lastly soil media and topography. A value from 1 to 10 is then attributed to each factor. The lowest value represents the lowest contamination vulnerability. All these values are

[70] Office fédéral de l'environnement des forêts et du paysage, Berne (2004). Instructions pratiques pour la protection des eaux souterraines

then multiplied with their associated weight and finally summed up to give the global vulnerability value of a particular hydro geological unit.

The global trends to consider are:
- The deeper the water table, the less vulnerable the site is.
- The more annual infiltration, the more vulnerable the site is.
- Karstic aquifers are the most vulnerable, then sandstone. Metamorphic rocks are less vulnerable.
- Shallow soils, gravels and sandy soils are very vulnerable. Loams have an average sensitivity.
- Clays are the less vulnerable.
- The steeper the terrain, the less vulnerable the site is.
- Karstic or basaltic vadose zones are very vulnerable. Then come sandy vadose zones, sandstone and shale. The less vulnerable ones are made from clay.
- The higher conductivity, the more vulnerable the site is.

4.3 The impact of forests on water availability

Rainfall over land surfaces replenishes groundwater reservoirs and provides runoff in streams and rivers. Some of this rainfall is lost through:

- Interception of rainfall held on leaves and evaporated by the wind before it reaches the ground;
- Transpiration: water drawn up through plant roots and evaporated from leaves through the stomata (small pores in the leaf surface).

The interception of rainfall and transpiration rate for forests is usually greater than that for alternative vegetation, because they have more leaf cover in relation to ground area and a greater aerodynamic roughness of their canopies, and because they have a deeper root system (Willis 2002). Hydrologists and climatologists point out that forestry is important in the interception of rainfall, especially relative to grassland. Forestry increases the inception rate, and hence reduces the amount of rainfall percolating through to the underlying water table, and to streams and rivers.[71] Thus forestry can have an important effect on stream flows, but this impact varies according to forest rotation.

Although there is no full scientific consensus in the field of water flow in forest ecosystem some generalizations can be made:

Infiltration is higher in forest soil than in any other soil
Forest influences hydraulic conductivity and, as a result, infiltration capacity of the soil. Under a forest, soils present a very deep and efficient porosity, because of biologic activity and deep roots. In addition, the permanent vegetation cover in forest decreases the risk of crusts formation (due to erosion) and losses by runoff. Forest soil and its litter layer allow better infiltration and create a high water storage capacity. Absorption capacity can be enormous but depends on soil type (e.g. Cerda 1998[72]). According to these studies, forest soils act like a sponge. Vegetation limits runoff (Lavabre and Andreassian 2000[73]) but favor infiltration.

Forest consumes more water than any other vegetal cover
Forest intercepts a part from precipitations falling on the ground. Evapotranspiration of deciduous trees is 20 % higher than coniferous trees (Aussenac 1973[74]). In spring transpiration is higher in coniferous stands, but later is higher in deciduous stands (Aussenac and Boulangeat 1980). Trees with their deep roots can also better use water stored in soil. Forest soil structure also limits runoff losses.

[71] I.R. Calder (2007): Forests and water – ensuring forest benefits outweigh water costs. *Forest Ecology and Management, 251*, 110–120.
[72] Cerdà, A. 1998. Changes in overland flow and infiltration after a rangeland fire in a Mediterranean scrubland. Hydrological Processes, 12, 1031-1042.
[73] Lavabre, J. et V. Andréassian, 2000. Eaux et forêts. La forêt : un outil de gestion des eaux ? Cemagref, Antony. 147p.
[74] Aussenac G., Étude microclimatique de coupes par bandes en forêt d'Épinal (Vosges), Comparaison avec la coupe rase, Rev. For. Fr. XXV 4 (1973) 283-293.

4.4 The impact of forests on water quality

Forests can alter water quality through:

- The capture of atmospheric pollution: Conifers enhance the capture of atmospheric acid and other pollutants (termed .scavenging.), thus increasing the acidification of water in upland streams and rivers, although there is uncertainty about the scale of the impact.
- Forest operations. These can alter drainage water pathways, causing erosion and sedimentation down-stream; whilst pesticides can lead to contamination of soil drainage. Once contaminated it may take decades to restore ground water quality to a level suitable for drinking purposes.[75]

Forest operations can have differential impacts on water quality over the rotation period, over and above its base quality. Base quality depends upon soil, geology, and alternative vegetation, and land-use. For instance, areas with acid and acid sensitive soils, reflecting the inability of the bedrock to weather at a sufficient rate to counteract both the acidity generated within the soils, and the impacts of acidic atmospheric pollution.[76]

In general one can say that:

Forest is the best soil cover in watersheds. There are very few pollutants inputs in forest ecosystems. Usually, carbon, phosphorus and nitrogen cycles are balanced and there are no or very few losses. Many studies show that nitrogen concentrations are lower in forest soils than in any other soils.

Water quality depends on forest type. Nitrification is active in aerobic conditions and in soils rich in Ca2+. Under tempered climate, in a deciduous forest, nitrogen absorption is almost equal to annual mineral nitrogen production in mull humus (Duchaufour 1997[77]) and there are few losses into underground water. In acidic or less oxygenated soils (moder humus, coniferous forests), ammonification is the main process. Ammonia is adsorbed on clay and releases H+ and Al3+ ions. As a consequence, the soil is acidified. Coniferous canopy catches more air pollutants, leaching is therefore higher. Moreover, in acidic soils, there is less buffer effect. Forests can therefore receive more nitrogen than they can use it. There is a risk of nitrogen saturation and that nitrogen goes into underground water. The situation is different in riparian forests where denitrification by micro-organisms plays a very important role (Burt et al. 2002[78]). Riparian forests could then store more nitrogen than they need it.

Passive and active protection of forest can be now distinguished. By its presence, forest decreases or prevents activities that could endanger water quality (no fertilizer or pesticides, no dangerous materials deposition). This is the passive protection by forests. Active protection encompasses all processes where forest influences directly water quality and quantity. In forests, biochemical cycles are balanced, water infiltrates better, roots structure the soil and therefore water can be better in contact with humus or clay minerals. Forest soils really purify water. But this effect can be affected by air pollution and deposition on canopy.

4.5 The influence of forest management on the water cycle

4.5.1 Influence of harvesting

In quantity

Many studies show that, after a forest cut, runoff increases and there is more superficial water flowing in the watershed. But there are few studies concerning underground water flows after a forest cut and results are contradictory.

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[75] Forestry Commission (2000): Forests and Water Guidelines. Third Edition. Forestry Commission, Edinburgh.
[76] Willis, K.G. (2002). Social & Environmental Benefits of Forestry Phase 2: Benefits and costs of forests to water supply and water quality. Report to Forestry Commission, Edinburgh.
[77] Duchaufour, P. 1997. Abrégé de pédologie : sol, végétation, environnement. Masson, Paris.
[78] T. P. Burt, G. Pinay, F. E. Matheson, N. E. Haycock, A. Butturini, J. C. Clement, S. Danielescu, D. J. Dowrick, M. M. Hefting, A. Hillbricht-Ilkowska, V. Maitre (2002). Water table fluctuations in the riparian zone: comparative results from a pan-European experiment Journal of Hydrology, Volume 265, Issues 1-4, Pages 129-148

In quality

The influence of forest harvesting depends on the type of harvest. Main harvest types studied in the literature are clear cut, strip cut and single tree cut. Studies show that the presence of natural regeneration has a huge impact on underground and surface water quality. This means that the effects of a windstorm or a clear cut depend a lot on the forest site.

Harvesting wood modifies or stops natural biogeochemical cycles and some harvesting methods can increase temporary nutrients leaching. Because of this, no clear cut should be made in zones saturated in nitrogen. After a clear cut, sun radiation coming to the earth is more intense, temperature increases in organic horizons and therefore mineralisation and nitrification increase (Weis et al. 2006[79]). Moreover, the increase of water that infiltrates into the soil after a clear cut increases nitrogen leaching during the first years. This phenomenon has been recorded in many studies. Wenger (1984[80]) found that this effect can happen after a 1.000 m² cut. Progressive cuts that maintain forest cover on the ground limit nitrogen migration in infiltration water. But the amount of nitrogen that is leached depends a lot on forest site and on the nitrogen saturation. Regeneration decreases a lot of nitrogen leaching after a cut (Weiss et al. 2001[81]). Therefore it is very important to have successful regeneration in forest areas.

Tree branches and cullwood accumulate also nitrogen (Dissmeyer 2000[82]), but their removal from forest has to be thoroughly examined because other very important nutriments are also exported (Ca2+, Mg2+, etc.). The area of forested land is also important regarding atmospheric deposition. Deposition decreases from forest border to the middle of the forest. Therefore, small dispersed forests accumulate more pollutants than a huge continuous forest (Spangenberg and Kolling 2004[83]).

Studies in the USA have shown that accelerated nutriment leaching did not occur after heavy cutting, but did follow when herbicides sustained barren conditions after clearcutting. Sediment increases in in-streams exports are minor and short-lived and mostly from roads when best management practices (BMP) are conscientiously employed (Adams et al. 2002[84]). Another study found that forest practices with the greatest potential for causing erosion and stream sedimentation are road construction, tractor skidding of logs and intensive site preparation (Stednick 2008[85]). Undisturbed forest watersheds usually have erosion rates of about 0.57 tonnes/ha/year. Typical timber harvesting and road construction activities may increase rates to 0.11 to 0.57 tonnes/ha/year. More intensive site preparation treatments such as slash wondrowing, stump shearing, or roller chopping may increase soil erosion rates up to 11.4 tonnes/ha/year. However, many different studies have shown very different results and therefore it is not possible to generalise any of them. Some show that cuts have a huge impact on nitrogen release, some do not. Yet it is possible to summarize that clear cuts induce a sudden and strong nitrogen increase in underground water. Water quality remains acceptable, except excessive suspended matter loads because of logs extraction. This influence is limited in the time.

[79] Weis, W., Rotter, V., Gottlein, A. (2006). Water and element fluxes during the regeneration of Norway spruce with European beech: Effects of shelterwood-cut and clearcut. Forest Ecology and Management, 224 (3), p.304-317.
[80] Wenger, K.F. (ed). 1984. Forestry Handbook. Society of American Foresters, Washington DC (USA). 1335p.
[81] Weiss, W., Huber, C., Gottlein, A. (2001). Optimizing Nitrogen Management in Food and Energy Production and Environmental Production: Proceedings of the 2nd International Nitrogen Conference on Science and Policy. TheScientificWorld 1.
[82] Dissmeyer, G.E. (ed) 2000. Drinking water from forests and grasslands: a synthesis of the scientific literature. Gen. Tech. Rep. SRS-39. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 246 p.
[83] Spangenberg, A., Kolling, C. (2004). Nitrogen Deposition and Nitrate Leaching at Forest Edges Exposed to High Ammonia Emissions in Southern Bavaria. Water, Air and Soil Pollution, Vol. 152, Numbers 1-4, p. 233-255.
[84] ADAMS (M.B.), EDWARDS (P.J.), KOCHENDERFER (J.N.), WOOD (F.). (2002). Fifty years of watershed research on the Fernow experimental forest, effects of forest management and air pollutipon in hardwood forests. p. 391 à 396.
[85] Stednick, J.D. (ed.). Hydrological and Biological Responses to Forest Practices. Springer.

4.5.2 Influence of tree species

Infiltration is higher under deciduous trees than under conifers. In winter time, infiltration is much higher under deciduous trees than under conifers. During the vegetation period, infiltration is higher under young stands and is independent from tree species.

There is less nitrogen losses under deciduous trees than under conifers. On the one hand, the nitrogen cycle is better balanced under deciduous trees:
- Soils are usually less acidic and biologic activity is more efficient in deciduous litter;
- Broadleaved trees have deeper roots and therefore catch more nitrogen.

On the other hand, the « acidic rain » effect is stronger in conifer stands:
- There is more nitrogen deposition on canopy and more nitrogen input in the soil: except alder and acacia trees that fix nitrogen, deciduous trees catch less atmospheric pollutants.
- Soils are more acidic and cannot buffer pollutants inputs. The water saturated zone is reached quicker by pollutants.

To conclude, deciduous trees consume less water than conifers. For example, Rothe et al. (2002[86]) measured that annual percolation fluxes are 223 mm under spruce stands and 329 mm under beach trees in Bavaria. Therefore, for the same quantity of leached nitrogen, the concentration is higher under conifers.

4.5.3 Influence of tree age

There is less nitrogen loss under a young growing forest than under an old forest. In a mature forest stand, nutrient uptake by roots is lower. In addition, the “acidic rain” effect is more important in mature forests because the canopies are bigger and pollutant interception is higher.

4.6 Effects of afforestation and plantation forestry

Planted forests continue to expand and their contribution to global wood production is approaching 50 % of the total [87]. Plantations can represent an opportunity for the restoration of landscape functions, but they can also represent a threat to natural systems. Trees planted for commercial or environmental purposes may use more water than the crops or pastures they replace at the same site. The impact of forests on water will not be uniform
across all the areas planted: it will be strongly ecosystem-specific, being influenced by the nature of the water flows, landscape features, area and viii density of plantings, and management.

In many situations afforestation can decrease surface water generation and groundwater recharge. This is of concern if forest expansion occurs where water resources are already under pressure. Many such systems are found in water-limited regions where increases in irrigated land have helped sustain a growing population and further growth is increasingly constrained by water.[88] Under such conditions, it may not be surprising that any activity that can lead to a potential reduction in water resources is met with opposition. Plantation forestry can be such an activity where it draws from the same groundwater system, or more commonly, occurs in the wetter upper part of basins, using water that might otherwise have flowed further downstream. The water argument has fuelled the wider debate about the balance of benefits and downsides of plantation forestry.[89]

Scientific evidence that afforestation of agricultural land reduces stream flow has accumulated and permeated into the public consciousness. At the same time afforestation is still widely promoted as a cure for a wide variety of other water related problems, including stopping or at least reducing river flooding, landslides, salinity, soil erosion,

[86] Rothe, A., Huber, C., Kreutzer, K., Weis, W. (2002). Deposition and soil leaching in stands of Norway spruce and European Beech: Results from the Höglwald research in comparison with other European case studies. Plant and Soil, Vol. 240, Number 1, p.33-45.
[87] FAO, State of the World’s Forests 2007, Rome.
[88] T. Oki, S. Kanae (2006): Global hydrologic cycle and world water resources. *Science 313,* 1068–1072.
[89] R.B. Jackson, E.G. Jobbagy, R. Avissar, S.B. Roy, D.J. Barrett, C.W. Cook, K.A. Farley, D.C. Le Maitre, B.A. McCarl, B.C. Murray (2005): Trading water for carbon with biological carbon sequestration. *Science 310,*1944.

river pollutant loads and global warming. Gradually, however, these services too are increasingly coming under scrutiny.[90]

Van Dijk and Keenan[91] conclude that afforestation on agricultural land:

- Will generally reduce average streamflow and groundwater recharge, but to a degree that depends on current landscape hydrology and on forest characteristics;
- Often reduces low flows to a similar or greater degree, but with possible exceptions where afforestation can restore soil hydrological function in degraded agricultural catchments;
- Is likely to affect water resources security downstream to a lesser degree, depending on the scale of afforestation and its position in the water system;
- Typically reduces the volume of sediment, nutrients and salt volumes transported into river systems when designed and managed well, but will not necessarily reduces pollutant concentrations;
- Seems unlikely to reduce major large-scale flooding or deepseated land slides, but has been demonstrated to reduce shallow land slides and local 'flash' floods;
- May influence global climate, but at current afforestation rates probably only negligibly; and
- Possibly enhances local to regional rainfall in some environments.

4.7 Best practices in forest management

The role of forests in stabilizing soils and protecting watersheds is universally recognized. Best Management Practices (BMPs) by definition are practical and efficient technologies to protect water quality. When a forest is disturbed, the potential for erosion and degrading water quality increases. Water quality is affected by sediment levels, water temperature, streamflow, nutrient levels, and dissolved oxygen levels. BMPs can minimize, eliminate or reverse water quality impacts. The USDA Forest Service published a guide for BMPs on their website.

A detailed list of BMPs devised by Forest ASYST (2007)[92] and the USDA Forest Service exists and there is also a forest operations checklist, derived from the Forestry Commission's (2000) "Forest and Water Guidelines".

According to the Principles of the continuous cover forestry approach [93], adapt the forest to the site, adopt a holistic approach to forest management, maintain forest conditions and avoid clearfelling, the growing stock and stand structure, this approach is suited to an era of multi-purpose forestry where environmental, recreational, aesthetic and other objectives are as important as timber production. In particular, continuous cover forestry is seen as a means of reducing the impact of clearfelling and the associated changes that this produces in forest landscapes and habitats. Continuous cover silviculture has recently become important due to a number of factors, such as the Rio-Helsinki process, the requirements of certification and an international movement favouring more natural forest management.

The Ministrial Conference for the Protection of Forests in Europe [94] (MCPFE) consists of a group of European countries which have been successfully developing cooperation in the field of forest policy towards sustainable forest management (SFM). Four Ministerial Conferences on the Protection of Forests in Europe held in Strasbourg (1990), Helsinki (1993), Lisbon (1998), Vienna (2003) resulted in agreed commitments at a political level with regard to sustainable management of forests. The MCPFE has developed Pan-European Indicators for Sustainable Forest Management which are divided in the following categories: Maintenance and Appropriate Enhancement of Forest Resources and their Contribution to Global Carbon Cycles, Maintenance of Forest Ecosystem Health and Vitality, Maintenance and Encouragement of Productive Functions of Forests (Wood and Non-Wood), Maintenance, Conservation and Appropriate Enhancement of Biological Diversity in Forest

[90] FAO (2005): Forests and floods: drowning in fiction or thriving on facts? Forest Perspectives 2. RAP Publication 2005/03. FAO, Rome, 30 pp.
[91] A.I.J.M. van Dijk, R.J. Keenan (2007): Overview: Planted forests and water in perspective. *Forest Ecology and Management 251,* 1-9.
[92] Forest Asyst (2007): Forest Landowner's Assessment Guide. Soil and Water Quality, at www.forestasyst.org/soilwater.html .
[93] Principles of the continous cover forestry approach, The Research Agency of the Forestry Commission, UK http://www.forestresearch.gov.uk/website/forestresearch.nsf/ByUnique/INFD-63CDA2
[94] http://www.mcpfe.org/system/files/u1/List_of_improved_indicators.pdf

Ecosystems, Maintenance and Appropriate Enhancement of Protective Functions in Forest Management (notably soil and water), Maintenance of other socioeconomic functions and conditions.

A concrete example of the best practices for protection of groundwater can be found in the city of Munich. There it was already discovered in the year 1880 that the sources of the 'Mangfalltal' would be very important for the drinking water supply of the city [95]. In the next hundred years, the land ownership policy of the city had a long-term perspective on securing this extraction area of water in the Lower Alps, 40 kms south of Munich. In 1996, ¾ of the yearly water use of the city and surrounding municipalities came from this source at the foot of the Taubenberg. The land owned by the city in the water source area consists of 1500 ha of forest, which is one third of the total forest land of the city. Since over 50 years, the forest protecting the water supply is managed by staff of the city according to close-to nature forest management principles, based on excellent water quality and high water quantity and transforming the forest from monoculture to a highly diverse and species rich forest. The forest ensures filtering of rainwater for the soil. This reduces the impact of pollutants on the groundwater. The mixed forest also provides a root and soil structure that facilitates large water storage and provides protection against storms or other climatic impacts and attacks of insects or funghi.

The decision of Munich to secure land, reforest and apply close-to-nature forest management practices for water protection has proved to be good investment. Even though purification of water is only one of the functions of forests, this example shows how high the value of the forest ecosystem is.

The information on best practices for forest management and its impact on groundwater described in this chapter and the knowledge obtained from case studies and publication material will be used to determine the scope for development of PES schemes in relation to groundwater and forests in the EU in the next chapter.

5 EU Policy recommendations for groundwater and forest PES schemes

The development of mechanisms to reward forest owners for the production of non-market benefits is becoming more and more a trend at a global, national and local levels.

• Global: One example is the current development of a future international regime to reduce emissions from deforestation and degradation in developing countries (REDD) for the post-2012 protocol under the United Nations Framework Convention on Climate Change
• National: A clear sign in this regard is the ongoing development of and discussion about national policies, strategies and/or legislation on PES in different countries (e.g., in Brazil, Costa Rica, Peru, Colombia, China).
• Local: In the EU, the existence of relatively new forest-groundwater PES schemes as well as the list of projects under development which were described in Chapter 3, proof this trend also at the local level.

For this study, establishing cases where forests play a positive role in the provision of groundwater related ecosystem services and the existing EU policy and funding instruments must be the point of departure for development of PES schemes.

Based on the information collected during this study and described in the previous chapters, it can be concluded that PES schemes linked to forests and groundwater are in an early stage of development in the EU member states and due to the limited availability of time to collect existing case studies, this study cannot provide a complete guide for the future development of such schemes in different EU member states. However, the study provides and shows the importance of 1) scientific evidence of the positive relationship between forests and groundwater quantity/quality, 2) economic valuation of ecosystem services as a first step in the development of PES schemes, and 3) ensuring sufficient funding sources that will enable or support future payment schemes.

The next section in this chapter will provide an overview of EU policy and funding instruments that could offer opportunities for the development of PES schemes in the field of forests and groundwater in the EU. In the final section on recommendations, important elements to be considered when developing PES schemes will be addressed.

[95] Wimmer, F. (1996), Der Wald als Hüter der Quellen, in Ökologische Waldwirtschaft, Grundlagen – Aspekte – Beispiele, Hermann Graf Hatzfeldt

5.1 Overview of EU policy instruments and funding mechanisms in relation to development of PES

A variety of EU policies and funding instruments address environmental and social dimensions of sustainable forest management and environment in general. In this section, a short summary of such funds and financial instruments shall be given, as these are considered to be of relevance for exploring further opportunities for the development of PES in relation to groundwater and forests. For details on the relevant EU policy and funding instruments, see annex 3.

LIFE +

The LIFE + programme (2007-2013) is based on three pillars:

- LIFE+ Nature and Biodiversity
- LIFE+ Environment Policy and Governance
- LIFE+ Information and Communication.

The general objective of LIFE + is to contribute to the development, implementation, monitoring, evaluation and communication of Community environment policy and legislation as a contribution to promoting sustainable development in the EU (Commission of the EC 2004). LIFE+ will support in particular the implementation of the 6th Environmental Action Programme which aims at combating climate change, halting the decline in nature and biodiversity, improving environment, health and the quality of life, promoting the sustainable use and management of natural resources and waste and developing strategic approaches to policy development, implementation and information/awareness raising.

In relation to the protection of water, one of the objectives under the pillar LIFE+ Environment Policy and Governance (Annex II, item 3) is: to contribute to enhanced water quality by developing cost-effective measures to achieve good ecological status in view of developing the first river basin management plan under Directive 2000/60/EC of the European Parliament and of the Council (Water Framework Directive) by 2009.

In relation to the protection of forests the following objective has been formulated under the pillar LIFE+ Environment Policy and Governance (Annex II, item 11): to provide, especially through an EU coordination network, a concise and comprehensive basis for policy relevant information on forests in relation to climate change (impact on forest ecosystems, mitigation, substitution effects), biodiversity (baseline information and protected forest areas), forest fires, forest conditions and the protective functions of forests (water, soil and infrastructure) as well as contributing to the protection of forests against fires.

These two objectives under LIFE+ show clear opportunities for the development of PES schemes, using current EU funding mechanisms.

EU Water Framework Directive

The WFD is the operational tool for achieving the EU's goal of 'good status' for all EU waters by 2015. It aims to set out a modern, holistic and ambitious policy for the management and protection of EU water bodies based on management plans for river basins. Member States are called on to implement the first of these plans by 2009 at the latest. As any Directive, the WFD must be transposed into national legislation in order to fully gain its legally binding nature.

The Water Framework Directive establishes a legal framework to protect and restore clean water in sufficient quantity across Europe and includes the "Polluter pays principle": The introduction of water pricing policies with the element of cost recovery and the cost-effectiveness provisions are milestones in application of economic instruments for the benefit of the environment. This will contribute to the sustainable management of scarce resources.

On 12 December 2006, the European Parliament and the Council adopted the new Groundwater Daughter Directive7 (2006/118/EC) in accordance with Article 17 WFD. The Daughter Directive complements and specifies the WFD on some issues. First, it establishes EU-wide quality standards for nitrates and pesticides that must be met to comply with “good groundwater chemical status”. In addition, Member States will have to establish national standards (threshold values) for other pollutants on the basis of the substances of most concern for groundwater pollution on national, regional or local levels. Finally, it reinforces existing measures to prevent or limit inputs of pollutants into groundwater. For the member states, the assessment of the current levels of recovery of the costs of water services (Art. 9 WFD), is highly important in order to meet their obligation to impose a water pricing policy that encourages consumers to use water resources more efficiently. Pricing policies are meant to recover the costs of water services, including those relating to the environment and the use of resources.

The Milestones of the WFD, as described in chapter 2, show that pricing policies have to be introduced by Member States by 2010 and environmental objectives have to be met in 2015.

The WFD as well as the Groundwater Daughter Directive, provide different instruments and concepts which have a great potential to promote the development of groundwater related PES schemes in the future. They create political support for countries aiming to prevent the further deterioration of groundwater quality and to protect and enhance the status of aquatic ecosystems and, with regard to their water needs, terrestrial ecosystems (Art. 1 a) of the WFD). The WFD thus provides an instrument which introduces a “new ecological vision” and creates an incentive for member states to further improve their groundwater policies and legislation, potentially also by using market instruments for the conservation of groundwater related ecosystem services. Since the WFD provides flexibility in achieving its goals in the most cost effective way, the member states can apply different instruments, to meet their legal obligations. Compliance with and enforcement of the set environmental standard is also ensured through the monitoring procedures and review mechanisms foreseen. Such monitoring is recognized as one of the most critical aspects of establishing and operating PES, since it is needed to ensure the sustainability of PES.

Since the WFD provides flexibility in achieving its goals in the most cost effective way, member states can apply different mechanisms, including PES, to meet their legal obligations.

Rural Development Regulation

The essential rules governing rural development policy for the period 2007 to 2013, as well as the policy measures available to member states and regions, are set out in Council Regulation (EC) No. 1698/2005. Under this Regulation, rural development policy for 2007 to 2013 is focused on three themes (known as "thematic axes"). These are:

- Improving the competitiveness of the agricultural and forestry sector;
- Improving the environment and the countryside;
- Improving the quality of life in rural areas and encouraging diversification of the rural economy.

To help ensure a balanced approach to policy, Member States and regions are obliged to spread their rural development funding between all three of these thematic axes. A further requirement is that some of the funding must support projects based on experience with the Leader Community Initiatives. The "Leader approach" to rural development involves highly individual projects designed and executed by local partnerships to address specific local problems.

The actual potential for funding environmental protection, restoration and sustainable forest management measures that contribute to the quality of groundwater, as well as to the economic value of forests, depend on the priority setting of EU Member States.

Rural Development Policy states in article 41 (COUNCIL REGULATION (EC) No 1698/2005) that: “Forest-environment payments should be introduced for voluntary commitments to enhance biodiversity, preserve high-value forest ecosystems and reinforce the protective value of forests with respect to soil erosion, maintenance of water resources and water quality and to natural hazards”. This is a strong support for the establishment of PES schemes.

Opportunities for funding PES schemes through existing EU regulations

When we combine the elements of LIFE+, the Water Framework Directive and Rural Development Regulation described above, a number of important opportunities arise for the development of PES mechanisms at an EU and Member State level

The following table shows the interlinkages between these EU policies and instruments and their connection to funding options for the development of PES schemes for forests and water.

Policy	Instrument	Connection	Opportunities for PES
Birds and Habitats Directive, Natura 2000	LIFE +	As part of the general objective of LIFE +, integration of the environment into other policies, thereby contributing to sustainable development, is a key element	The objective of LIFE+ indicates strongly that the interlinkages between different policy areas, which in this study relate to the WFD and RDR should be strengthened, thereby contributing to the protection of the environment and sustainable development.
		Measures eligible for LIFE+ funding: site management, purchase of land to restore the integrity of Natura 2000 sites or achieving the desired conservation outcome	These measures under LIFE+ could be used to compensate forest owners for forest management practices which contribute to maintenance of the ecological system or to reforest areas that were previously at risk of losing their biodiversity value
		One of the objectives of LIFE+ (Annex II, item 3): To contribute to enhanced water quality by developing cost-effective measures to achieve good ecological status	LIFE + funds can be used to enhance the ecological value of forest areas, thereby contributing to the quality of drinking water
		Forest priority areas of Action: contributing to sustainable forest management in relation to MCPFE	Sustainable forest management practices are of importance for achieving EU biodiversity objectives as well as for ensuring the supply of drinking water
Water Framework Directive	To achieve the objectives of the WFD, Member States can launch new investment projects, implement new regulations, set up economic instruments, and negotiate agreements with polluters.	The WFD recognises the importance of the cycle linking groundwater and surface water with terrestrial ecosystems.	Using the financing mechanisms available under the WFD for protecting forests, contributes to deliver on the objective of good status of groundwater. EU integrated river basin management is based on the natural functioning of freshwater ecosystems, including wetlands and groundwater and protection of ecosystem functions is a key element.
		WFD foresees integrated river basin management which is based on the natural functioning of freshwater ecosystems; including wetlands and groundwater and protection of ecosystem functions is a key element.	Sectoral integration is essential for an integrated water resources management approach. It provides a perfect opportunity to assess and value different ecosystems and their services, to identify the beneficiaries of these services (including the benefits of forest management for groundwater resources), and to build the case for the conservation of ecosystem services. Integrated water

			resources management through the development of river management plans can be a trigger for the creation of forest-groundwater PES.
		The WFD introduces the principle for paying the full cost of water services (the polluter pays princile), including environmental services such as clean drinking water	This component of the WFD provides an opportunity to establish payments for harmful effects to ecosystems, costs that normally would not appear on financial balance sheets: payment for ecosystem services. EU Member States have to make sure to recover these costs, by for example a charge on the water price, which can be used to protect the water/forest ecosystem.
		The WFD introduces the principle of full cost recovery of water services, including environmental services.	If we assume that water services include forest ecosystems, this provides an opportunity to include forest ecosystem services in water pricing policies which can be the basis for PES funding.
Rural Development Regulation			
Axis 1: Improving the competitiveness of the agricultural and forestry sector	**b) targeting the sustainable use of forestry land through:** **(ii) improving the economic value of forests**	(Article 27) 1. Investment support provided for in Article 20(b)(ii) shall be granted for forests owned by private owners or their associations or by municipalities or their associations. 2. Investments shall be based on forest management plans for forest holdings above a certain size to be defined by the member states in their programmes.	The establishment of a forest from even-to uneven aged stands according to the principles of close to nature forest management , requires a transition period, where income will be lower for a number of years. This could be interpreted as an investment, according to article 27, which will lead to a higher economic value and an improvement of the ecosystem value of the forest, based on a sustainable forest management plan. The transformation of the forest in water protection areas is precondition for close to nature forest management leading to opportunities for: • Financial support for development of PES • Inclusion of PES in members states strategies and programs on rural development.
	v) improving and developing infrastructure related to the development and adaptation of agriculture and forestry;	Art.30. Support provided for in Article 20(b)(v), may cover notably operations related to access to farm and forest land, land consolidation and improvement, energy supply and water management.	Integrating water management measures with reforestation of agricultural land or transforming the structure of existing forest stands can be achieved through: • Compensation for provision of drinking water, • development of water protection infrastructure
Axis 2: Improving the environment and the countryside	**(b) measures targeting the sustainable use of forestry land through:**	1. Support under this subsection shall be granted only for forests and wooded areas owned by private	Forest and land owners as well as municipalities working according to the principles of sustainable forest management contribute to the improvement and maintenance of

		owners or by their associations or by municipalities or their associations. 2. Measures proposed under this subsection in areas classified as high or medium forest fire risk within the framework of the Community action on protection of forests against fires shall conform to the forest protection plans established by the Member States for those areas.	biodiversity values of forestry land. In water protection areas such management practices guarantee clean drinking water and
	(i) first afforestation of agricultural land;	Art. 43 First afforestation of agricultural land	Stimulating investement in the afforestation of land leads to rehabilitation of sites and improves water quality, biodiversity values and provides income diversification for farmers and land owners. Under this article a) establishment costs, as well as b) an annual premium per hectare afforested to contribute to maintenance costs for a maximum of 5 years and c) an annual premium per hectare to contribute to covering loss of income resulting from afforestation for a maximum of 15 years, will be provided.
	(ii) first establishment of agroforestry systems on agricultural land;	Art. 44 1. Support provided for in Article 36(b)(ii), shall be granted to farmers to create agroforestry systems combining extensive agriculture and forestry systems. Support shall cover the establishment costs.	Agroforestry systems based on sustainable management principles, can provide benefits for groundwater quality, especially when a change is made from intensive agriculture.
	(iii) first afforestation of non-agricultural land;	Art.45 1. Support provided for in Article 36(b)(iii) for afforestation of land not eligible under Article 36(b)(i) shall cover the establishment costs.	Afforestation can contribute to protection of watershed areas and provides land owners with an alternative source of income
	(iv) Natura 2000 payments;	Art. 46 Support provided for in Article 36(b)(iv), shall be granted annually and per hectare of forest to private forest owners or associations thereof in order to compensate for costs incurred and income foregone resulting from the restrictions on the use of forests and other wooded land due to the implementation of Directives 79/409/EEC and 92/43/EEC in the area concerned.	Compensation of restrictions on the use of forests in Natura 2000 areas, contributes to restoration of natural ecosystems functions and provides forest owners with an incentive to prevent the pollution of groundwater in forest areas.
	(v) forest-environment payments;	Art. 47 1. Forest-environment payments provided for in Article 36 (b)(v), shall be	This measure fits well with the development of PES schemes, as it creates incentives for forest-environmental commitments

		granted per hectare of forest to beneficiaries who make forest-environmental commitments on a voluntary basis. These payments shall cover only those commitments going beyond the relevant mandatory requirements. These commitments shall be undertaken as a general rule for a period between five and seven years. Where necessary and justified, a longer period shall be determined in accordance with the procedure referred to in Article 90(2) for particular types of commitments.	contributing to the protection of drinking water
	(vii) support for non-productive investments.	Support provided in Article 36(b)(vii), shall be granted for investments in forests: (a) linked to the achievement of commitments undertaken pursuant to the measure provided for in Article 36(b)(v), or other environmental objectives; (b) which enhance the public amenity value of forest and wooded land of the area concerned.	• Compensation for provision of drinking water, • Improvement of quality of environment,
Axis 3 The quality of life in rural areas and diversification of the rural economy	(iii) conservation and upgrading of the rural heritage;	Art 57 The support referred to in Article 52(b)(iii) shall cover: (a) the drawing-up of protection and management plans relating to Natura 2000 sites and other places of high natural value, environmental awareness actions and investments associated with maintenance, restoration and upgrading of the natural heritage and with the development of high natural value sites; (b) studies and investments associated with maintenance, restoration and upgrading of the cultural heritage such as the cultural features of villages and the rural landscape.	• Financial support and compensation for protection and management of Natura2000 sites, • Restoration of natural heritage sites, • Studies and development of restoration or protection programs

5.2 Recommendations for development of PES schemes for forest and groundwater in the EU

The policy and funding instruments described in the previous section, have in common that they offer funding opportunities for nature and biodiversity in relation to regional economic development with a strong emphasis on sustainability. In this section, the main entry points for the establishment of PES initiatives, projects and policy developments to support the maintenance and restoration of forest ecosystems that are important for the provision of groundwater across the EU will be provided.

As shown in the previous chapters of this report, based on the current EU policy framework and funding instruments available, opportunities for the development of PES schemes in relation to groundwater and forests have not been explored until now. PES schemes for agriculture are more frequently seen. For example, voluntary schemes that offer payments to farmers who agree to desist from certain damaging operations or carrying out environmentally sensitive activities have become an integral part of current European agricultural policy.
The MCPFE fifth conference in Warsaw, 2007 resolution on forests and water, emphasises the role of forests and forest management for biodiversity of water ecosystems and in protecting water quality and managing water resources for the quantity of all waters. In addition, it stresses that the full economic value of forests has to be adequately recognised and in particular the value of providing ecosystem services. The signatory states and the European Community commit themselves in this resolution to sustainable management of forests in relation to water and coordinating policies on forests and water. The former includes the maintenance and enhancement of the protective functions of forests for water and soil through sustainable forest management, whereas the latter includes the development and improvement of policies for forest and water resources management that contribute to the maintenance of ecosystems and the sustainable provision of their services, to develop adequate or improve the existing institutional arrangements to better cooperate in addressing the interrelation between forest and water issues and to increase awareness of the relationship between forests and water as well as the potential of forests and their sustainable development to improve the water environment.

In addition there is special attention for the economic valuation of water-related forest services, emphasising:

• The assessment of the economic value of forest services related to quality and quantity of water resources and flood alleviation from which society benefits
• The incorporation of the economic valuation of water-related forest services into relevant policies and strategies on forests and water
• The facilitation of the development and implementation of measures which may include economic tools such as payment for ecosystem services, in order to broaden and diversify the financial basis for sustainable forest management and to maintain the protective functions of forests.

To protect groundwater and drinking supply in the EU for the future, practical and innovative solutions for environmental threats have to be developed. As indicated above, PES schemes can provide a valuable contribution and should become an integral part of relevant EU policies and funding instruments.

Currently, the protective functions of forests are seldom leading to any income generation for forest owners. Regulations to preserve high-value forest ecosystems and reinforce the protective value of forests with respect to soil erosion, maintenance of water resources and water quality, should be promoted more effectively among those stakeholders interested in using available EU funding mechanisms to start with the development of schemes for forest-environment payments. Restoration and maintenance of forest ecosystems is not only a high priority for the strengthening of Natura 2000 and biodiversity protection, but also for the protection of drinking water resources. In Natura 2000 sites, the economic function of forests, usually the highest priority in forest management, will have to be adapted according to the requirements of the ecological function and the conservation of biodiversity, which calls for changes in current forest management practices. Even more, the establishment of voluntary compensation agreements between the state or private companies and forest owners have already proved to be succesful in reducing deforestation in developing countries, and have now started to develop in different EU member states more specifically for protection of drinking water.

LIFE + projects tend to be regionally based and have developed workable solutions, which can feed into policy development, often by establishing best practice or guidelines. There is the potential to link LIFE- projects for the benefit of policy makers and others. Small scale PES projects can qualify as LIFE+ projects which help to develop PES experiences that benefit policy-making afterwards.

One of the key elements in the WFD is implementing the economic principle that polluters and users should pay for the natural resources they use and the damage they create. So far, the integration of this principle is still insufficiently reflected in the water pricing policies in most EU member states and the process to price water in line with its value as a natural resource has to be strengthened. The pricing of water needs to internalize the additional management costs of forests, which are incurred to cater for the needs of water protection. The segment of the water price, which covers these additional management costs has to be paid to the resource manager or owner. In

addition, it is important that water suppliers have the right to pass on environmental costs in the water price to their customers.

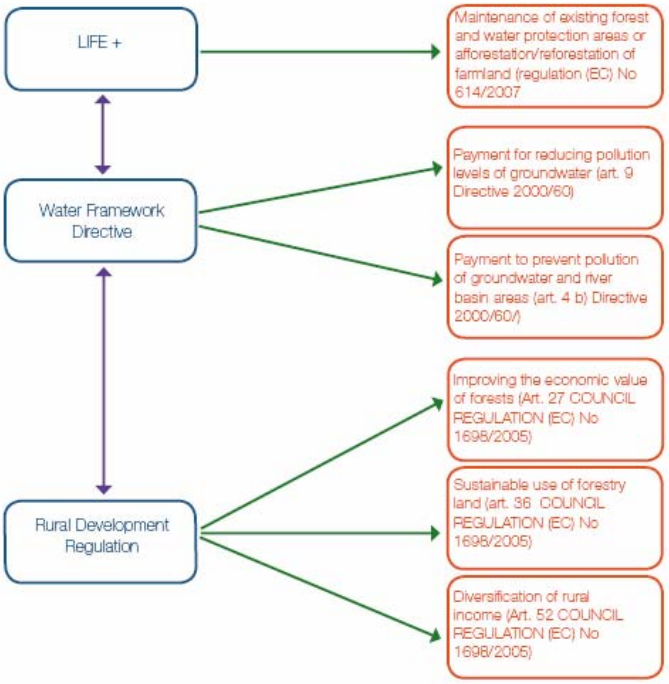
Prevention of pollution is more cost effective than reducing it once groundwater has already reached high levels of pollution. Costs of cleaning polluted water are clearly higher than establishing management practices for forests and water areas that prevent the deterioration of water quality. Therefore, having a system to pay for pollution, as suggested by the Water Framework Directive, according to its "Polluter Pays Principle", should be replaced by a system that provides incentives for the prevention of pollution. In general, incentives are a better tool than payments for obtaining commitment of water users and providers.

Considering water protection forests as "natural infrastructure" is vitally important to maintain the production of, inter alia, the ecosystem service of providing drinking water in required quantity and quality. In relation to water, the EU Rural Development Policy 2007-2013 states that support will be available for infrastructure related to the development and adaptation of agriculture and forestry to cover operations contributing to access to farm and forest land, land consolidation and improvement, energy supply and water management.Several examples show that it can be economically more efficient to invest in "natural infrastructure" than in physical infrastructure such as dams and water purification plants. The most famous example, in the New York Catskill-Delaware watershed shows how restoration of the natural ecosystems can contribute to reducing the costs of providing clean drinking water, now and in the future.

To protect watershed areas and to enhance the water quality to achieve a good ecological status, a strong link can be made between the Water Framework Directive and LIFE+, as the LIFE+ offers funding opportunities to invest in improvement of environmental protection.

Therefore, the various EU policy and instruments have to be combined to create complementary and cross-cutting methods for establishing payment for ecosystem services in relation to groundwater and forests (see the following diagram).

Opportunities for establishment of PES schemes in relation to existing EU policies and instruments



In the presented analysis of the 3 major policy directives and their relevance to forests and groundwater, one should differentiate between two complementary types of PES schemes, which are: 1) investments, such as the transformation of forests and reforestation and 2) those that are related to maintenance and management of the existing ecosystems.

It should be noted that under the current EU regulations, integration of environmental priorities in their spending programmes is not an obligation for individual member states. Therefore it is highly important that efforts are made to raise awareness with all parties involved, for the opportunities of PES schemes at a member state level. Rather than creating legal rights and obligations for compensation of forest owners for delivering the service of clean water, one should be offering voluntary schemes of incentives. EU Member States should be encouraged to follow this advice, taking into account that there are major differences among member states with regards to groundwater ownership, internalization of management costs of water protection forests into water pricing and the sharing of income generated by water use.

To conclude the analysis of opportunities for the development of PES based on existing EU policy and funding instruments leads to three options:

1. Use existing policies and regulations to introduce PES schemes
2. Introduce changes to existing policies regulations, to be adopted by Council, in order to better reflect the opportunities for PES with cross-linking the different policy areas. This also includes reviews of existing regulations, such as the CAP Health check
3. Design a comprehensive scheme or new Directive for PES

Annex 1: Overview surface water and groundwater in EU Member States

	Surface water %	Groundwater %	Overlap[1]	
Austria	71	8	8	
Belgium	66	5	5	
Bulgaria	94	30	26	
Cyprus	72	53	24	
Czech Republic	100	11	11	
Denmark	62	72	33	
Estonia	91	31	23	
Finland	97	2	2	
France	87	49	48	
Germany	69	30	29	
Greece	75	14	11	
Hungary	6	6	6	
Ireland	93	21	19	
Italy	89	22	16	
Latvia	47	6	6	
Lithuania	62	5	4	
Luxemburg	32	3	3	
Malta	1	99	0	
Netherlands	12	5	5	
Poland	86	20	19	
Portugal	55	6	6	
Romania	20	4	4	
Slovakia	25	3	3	
Slovenia	58	42	42	
Spain	98	27	25	
Sweden	98	11	11	
United Kingdom	98	7	6	
Source: FAO-AQUASTAT, 2005				
1 Overlap is the water that is shared by both the surface water and groundwater systems				

Annex 2: Overview contacts for data collection

Request for case study information	Response
Experts contacted	
Aristides Leitão, National Council on Environment and Sustainable Development (CNADS) Executive Secretary, Portugal	The Portuguese Council (CNADS) doesn't know any payment for ecosystem services or environmental services in forests
Maggie Charnely, EU and International Coordination, Defra, UK	we do not know of any specific ground water and forests payments – the closest anyone could find was an initiative in the Philippines (Silver bullet or fools' gold? A global review of markets for forest environmental services and their impact on the poor, Natasha Landell-Mills and Ina T. Porras March, IEED 2002)
Pierre Mathy, Pierre Mathy, Head of Unit, Management of Natural Resources, Environment Directorate, DG Research European Commission	I am not aware of any project addressing specifically the payment for the ecosystem services of groundwater in different European Member States in relation to forests.
Dr Jean-Daniel Rinaudo, BRGM (French Geological Survey) Water Department, Head of Economic Unit, France	"Examples of payments for ecosystem services provided by forest may exist in France, I have unfortunately never heard such cases. As elsewhere in Europe, existing PES schemes in France are mainly related to agricultural practices, with two major types: (i) cases where drinking water public utilities pay a compensation to farmers for reducing the level of pesticide and nitrogen use in their fields; and (ii) cases where farmers receive a compensatory payment for maintaining permanent grass fields (or other specific practices) in areas of specific ecological interest (Natura 2000 and others)".
Philippe Weiler, Manager Business Engagements WWF, Belgium	"I'm not really aware of concrete PES projects linking groundwater and forest management in which the payment aspects have really been incorporated".
Assoc. Prof. Josef Seják, Faculty of Environment - University of Jan Evangelista Purkyně, The Czech Republic	"As for the interactions among water and forest ecosystems we have several methodological approaches in the Czech Republic. For example, there is a method for valuing forest functions that also includes monetary valuation of hydrological functions of forests (of different forest ecosystems). Generally we develop two main ecosystem valuation methods (biotope valuation method and integrated forest function method) that study ecosystems from the systems approach. Systemic properties of living systems are in some contradiction with the utilitarian efforts to measure individual services of ecosystem parts (like groundwater versus forests). From that viewpoint it is not quite clear in the PES scheme who should pay to who".
Phoebe Kondouri, Assistant Professor in Economics - Athens University of Economics and Business, Department of International and European Economic Studies, Greece, who contributed to various DG Research groundwater projects (CYPRUS, ARID, AQUASTRESS, EUROLIMPACS, IASSON, SESAME), Greece	"I am not aware of any implemented incentive scheme for ecosystem services outside agriculture. It could be the case that some wetlands or Natura 2000 locations are used as tourism/recreational parks with an entrance fee, but I am not specifically aware of an already implemented scheme in Europe. I am currently working towards establishing such a scheme in Tamar, Northern UK. Such parks exist for wild life, but not explicitly for water and forests services".
Tom Bade, founder of the consultancy Tripleee on ecology and economy and author of a publication on the value of water , The Netherlands	"I am not familiar with any examples of PES in relation to groundwater and forest in Europe. The main reason for this situation is that the culture and mentality in countries such as the Netherlands is on governmental regulation of groundwater control and enforcement, instead of the role of the market".
John Varley, Director The Clinton Devon Estates, UK	"We do not receive any support / recognition for any benefits delivered by our woodlands. I am not aware of any scheme (eWGS / HLS etc) that recognises these benefits in the UK. My view is that these are not well understood and I will watch this with interest. Government policy recognises the biodiversity benefits of ancient and semi-natural woods thorough management grants and planting grants."
Zuzana Horvátová, Water Research Institute, Slovakia	we could suggest some pilot areas in Slovakia (like the catchment of Morava or Danube River…). But now there is no project with this topic running at our department. So now we can offer only partnership for a project that already started or is planned for the future.
Burkhard Schweppe-Kraft, expert economist of the German Federal Agency for Nature Conservation	Provided the information: "A Bibliography and Data Base on Environmental Benefit Valuation Studies in Austria, Germany and Switzerland. Part I Forestry Studies." Link: http://www.bfafh.de/bibl/htm/pe_pub25.htm
Sarah Hernandez, Chargée de mission "Biodiversité", Ministère de l'Ecologie, du Développement et de l'Aménagement Durables Direction des Etudes Economiques et de l'Evaluation Environnementale, Paris , France	The evian case study (payment to farmers for environmental friendly agriculture) is the only example I know.
Pierre Strosser, ACTeon Innovation, Policy, Environment, France	Provided information about the BRIDGE project: Background cRiteria for the IDentification of Groundwater thrEsholds and a study on the Environmental taxes and charges in the water sector. A review of experience in Europe
Coralie NOEL, Deputy Director, Office International de l'Eau, France	En France, le ministère de l'environnement a développé avec l'ensemble des acteurs de l'eau un Système national d'information sur l'eau (SIE) qui regroupe tous types de données sur l'eau, accessible à : http://www.eaufrance.fr. A la demande du ministère de l'environnement, l'Office international de l'eau a développé un site « Economie » au sein du Système national d'information sur l'eau : http://www.economie.eaufrance.fr, dans lequel sont regroupées des informations sur la tarification de l'eau, le financement des services de l'eau potable et de l'assainissement, la récupération des coûts des utilisations liées à l'eau, l'évaluation coûts-bénéfices, l'évaluation des coûts et bénéfices environnementaux
Rainer List, Wassergewinnung Leitung, City of Munich, Germany	For ground water protection, Munich City Works (SWM) have bought up land near the catchment areas at a very early stage. This land was bought for nature-oriented afforestation as groundwater recharge and water quality depend determinedly on wood proportion of the catchment areas or leased out to ecological farmers. Munich City Works do not subsidize private wood farmers for natural forest cultivation.

Nuria Hernández-Mora, Fundación Nueva Cultura del Agua, Zaragoza, Spain	While there have been some studies about the economic value of groundwater, primarily done by the Proyecto de Aguas Subterráneas of the Fundación Marcelino Botín in 1998-2001, and more recently by professors Alberto Garrido and Consuelo Varela of the Universidad Politécnica de Madrid, and to some extent by the Economic Analysis Group of the Ministry of the Environment, these have focused primarily on the productivity of groundwater and its contribution to different economic sectors, primarily agriculture. I am not aware of specific studies on the economic valuation of the ecosystem services provided by groundwater.
David Pithart, Institute of System Biology and Ecology of the Academy of Sciences of the Czech Republic	I am not aware about any project evaluating groundwaters as an ecosystem service in our country. We have applied for a project named "Ecosystem services of wetlands". The study site is the preserved floodplain with natural hydrological regime (periodic floods, high geo- and biodiversity). The project is aimed at water retention during high discharges and mitigation of flood waves, nutrient sinks and carbon sequestration. Most of the project is about quantification of natural processes, the economic study is only a minor part. To be honest, groundwater problematics is represented weakly, because we do not know very well how to quantify the infiltration from surface to groundwaters. Or, in other words, we have not addressed any professionals who are able to measure it. We plan to estimate it after quantificatrion of other water fluxes (discharge, evapotranspiration).
Jean-Daniel Rinaudo, BRGM (French Geological Survey), Water Department, Head of Economic Unit, 1034 rue de Pinville Montpellier, France	Although examples of payments for ecosystem services provided by forest may exist in France, I have unfortunately never heard such cases. As elsewhere in Europe, existing PES schemes in France are mainly related to agricultural practices. We can however observe that large drinking water utilities increasingly tend to install groundwater pumping fields in areas covered by forests as they provide a relative protection against surface pollution, agricultural non pont sources in particular. I have observed this in the Alsace region in particular (eastern France), with the cities of Colmar and Mulhouse for instance. Some municipalities also try to purchase large tracks of land located in the recharge area of their wells and afforest them for improving groundwater protection against surface pollution (pumping field of the Doller of the city of Mulhouse). This last strategy is constrained by the very high cost of purchasing land. However, large collectivities (at "département level") are starting to think of creating large scale hydro-forestry natural parks.
Bo Jellesmark Thorsen, Professor (Chair), D.Sc., Ph.D., Head of Division Division of Economics, Policy and Management Planning Forest & Landscape University of Copenhagen, Denmark	Provided the information for the case study in Denmark
Boris Greguska, Ph. D., Ministry of Agriculture of the Slovak Republic, Forestry Section	No relevant compensation mechanism/scheme (public/private) to be developed or implemented in particular in relation to forests and groundwater in the Slovak Republic. Based on outputs of the past and present research activities, forest ecosystem services in relation to quantity and quality of groundwater (as well as aboveground water sources) have been recognized and identified at a national level.
Sofia Blomquist, Specialist in the social values of forests The Swedish Forest Agency, Forest Division North	We don't have any payment for eco system services concerning groundwater quality in Sweden. The matter is not discussed in Sweden today, mainly due to the fact that groundwater of good quality is abundant in Sweden.
Zoltán Gribovszki from University of West-Hungary, Faculty of Forestry, Hungary	In the frame of our research activities we intensively investigate forest impact on shalow groundwater resources and stream baseflow, titles publications in the theme: Gribovszki Z. - Kalicz P. - Kucsara M., Streamflow Characteristics of Two Forested Catchments in Sopron Hills Acta Silv. Lign. Hung., Vol. 2. 2006. p. 81-92. Szilágyi J. Gribovszki Z., Kalicz P., Estimation of catchment-scale evapotranspiration from baseflow recession data: Numerical model and practical application results Journal of Hydrology, Volume 336, Issues 1-2, 30 March 2007, Pages 206-217. http://dx.doi.org/10.1016/j.jhydrol.2007.01.004 Gribovszki Z. - Kalicz P. - Szilágyi J. Kucsara M., Riparian zone evapotranspiration estimation from diurnal groundwater level fluctuations" Journal of Hydrology (2008) 349, 617 http://dx.doi.org/10.1016/j.jhydrol.2007.10.049 Szilagyi, J., Gribovszki, Z., Kalicz, P., Kucsara, M., On diurnal riparian zone groundwater-level and streamflow fluctuations, Journal of Hydrology, 2007. Közlésre elfogadva.
Raimundas Paliukas, Vice-Minister of Environment, Ministry of Environment of the Republic of Lithuania	Payments for ecosystem services of groundwater in forests are not applied in Lithuania, neither under implementation nor in project stage. Nonetheless , the question of different payments for forest ecosystem services is one of the relevant points in Lithuanian forest policy. Currently in Lithuania the forest environment payments according to Council Regulaion (EC) NO 1698/2005 for preserving Woodland Key Habitats (WKH) in private forests are under implementation. The amount of payment is calculated according to losses of incomes from wood, which potentially could be sold from the area of WHK. Additionally, in the nearest future the Ministry of Environment is going to order a study for evaluation of non-marketable social and ecological functions of Lithuanian forests.
Amélie CASTRO, Ingénieur Environnement - Territoire, Centre Régional de la Propriété Forestière d'Aquitaine, Bordeaux, France	AQUITAINE - FRANCE. Concerning the relationship between water quality in the Arcachon Bay (Bassin d'Arcachon) and its associated river, the Leyre. The Leyre catchment basin represents approximatively 600 000 ha. About 90% of this area is covered by forests, mainly composed of maritime pine (Pinus pinaster Ait.) stands mixed, at a landscape scale, with a small proportion of broadleaves trees stands of oaks and alders. Forestland belongs almost entirely to private owners. The soils are quite homogeneous, sandy and very poor, most of them podzols. They are characterised by an important superficial water table. The river Leyre is part of the Natura 2000 network. The Arcachon Bay is an important oyster production site and a touristic area with numerous swimming places. Both activities depend on good water quality. The forest contributes in several ways to preserve water quality. The economic value of this externality provide by forest management has never been calculated nor has been contemplated the possibility of it being rewarded as a service. Nevertheless, this area has been object of several technical, scientifical or statistical studies that can be used to provid

Andreas Christou, for the Director of the Department of Forests, Cyprus	I would like to inform you that the Cyprus Department of Forests is not involved in any kind of initiative related with payments for ecosystem services of ground water in forests.
Paola Gatto, Professore Associato and Laura Secco, Ricercatore - Dipartimento Territorio e Sistemi Agro-Forestali Università di Padova	implementation of PES for water services in Italy is at its very beginning (Piedmont can really be considered a 'pilot' experience where preparations take place to create a voluntary market for payment to reduce soil erosion and other hydro-geological risks), so the information required for filling in your questionnaire is not available at the moment, but is the object of our research. Even the cause-effects interactions between forestry and water regimes need further exploration. Reference is made to the study: New policy trends for the remuneration of forest services
Julien Fiquepron, Ingénieur forêt et eau IDF & INRA, LEF, Laboratoire d'Economie Forestière, France	Payments for forest owners are not contractually in place. In Rennes, the city bought land for afforestation to protect water sources, in the Alsace, Masevaux, in forests owned by the city, forest measures are being taken to maximise the water supply. This implies only one actors' involvement.
Organisations and networks contacted	
WWF-EPO	Contacts with WWF staff in the region and access to publications
European Landowners Organisation network	This network provided information on existing valuation studies and publications
Eurosite network	Request has only recently been sent around
IUCN Commission on Environmental Law	The IUCN Commission on Environmental Law (CEL) is a network of environmental law and policy experts from all regions of the world who volunteer their knowledge and services to IUCN activities, especially to those of the IUCN Law Programme. The network was contacted through its listserv which reaches more than 500 environmental law and policy experts. However, the request for information and follow up did not lead to any information on forest-groundwater PES in the EU.
IUCN Secretariat staff water, economics and forest programmes	Provided background information on PES schemes, publications and links and case studies outside of
CEPF network	Being the heart and representative of family forestry in Europe enhancing the values of private property through sustainable forest management, all members of the CEPF network (national forest oweners organisations in Europe) were informed about the study and asked for case study and background information. This was the source of information for the Denmark case study.
Eustafor	The Eustafor network supported the establishment of contacts with experts in the EU member states
Governments and municipalities in Member States	Contacts established with Finland, Denmark, Spain, Austria, Germany, Netherlands, France, UK, Ireland, Slovakia
Members of the Working Group on Groundwater	Our request for case study information was sent out by Mr. Bucki and has provided some response, but none of them provided us with relevant case study information
Poverty Environment Partnership (PEP) Working Group on PES	During the XI Poverty Environment Partnership (PEP) meeting in June 2007 Copenhagen, one of the recommendations of the session devoted to Ecosystem Services (ES) and Payments for Ecosystem Services (PES) was to put in place a PEP Working Group on ES and PES. The Working Group's purpose is to become a clearing house to identify and inform PEP members and other stakeholders about shared opportunities to use Ecosystem Services (ES) and Payments for Ecosystem Services (PES) to promote the Millennium Development Goals (MDGs) in general and sustainable development and poverty alleviation in particular. Participants come both from donor agencies and conservation NGOs, with occasional guest contributors at specific events or activities. Some of the institutions participating in this working group include: DGIS, SDC, Irish Aid, SIDA, Austrian Development Agency, World Bank, WWF, IUCN, UNDP, WRI, IIED, Katoomba Group and The Nature Conservancy (TNC).
Austrian Development Agency, and Österreichische Bundesforste AG Consulting	These contacts were established through the PEP Working Group on PES and lead to the Austrian case study. The contact person within the Österreichische Bundesforste AG Consulting was very interested in the project. But at the same time he refused to fill out the questionnaire and to share any detailed information. However, he referred to websites from where some information on the Austrian case study was taken.
Irish Department of Agriculture and Food (DAF), National Council for Forest Research and Development (COFORD), Coillte, and University College Dublin (UCD)	These contacts were also established through the PEP Working Group on PES, but could not provide any information on forest-groundwater PES cases in Ireland. COFORD - the National Council for Forest Research and Development - is an agency of the Irish Department of Agriculture and Food. COFORD was established in 1993 under the STRIDE Forestry Sub-Programme, an initiative of the European Commission. STRIDE provided initial funding for co-ordination of forest research in Ireland and the development of a research programme for the forest industry. COFORD is responsible for the development of national forest research and development policy and priorities, the formulation and implementation of programmes that address these priorities, and transferring the knowledge generated into practice.
Ecoagriculture Partners	Ecoagriculture Partners is an initiative which seeks to help ecoagriculture practitioners measure the social, economic, and ecological outcomes of landscape-scale management practices. The members of its International Steering Committee (ISC) include: Alternatives to Slash-and-Burn (ASB) Programme of the CGIAR, The Business and Biodiversity Offset Program (BBOP), Centro Agronómico Tropical de Investigación y Enseñaza (CATIE), CSIRO, Conservation International, Cornell University, Desertification, Drought, Poverty and Agriculture (DDPA) Consortium, The Forest Landscape Restoration Program of WWF, International Water Management Institute (IWMI), Landcare International, Model Forest Network, M.S. Swaminathan Research Foundation, The Nature Conservancy (TNC), Rainforest Alliance, Winrock International, ICRAF, The World Bank, IUCN. The focal point at Ecoagriculture Partners could not provide any information. A call for information was then published in the Ecoagriculture Partners Newsletter in March 2008. This newsletter is distributed once every two months to a listserv of over 2,700 ecoagriculture enthusiasts. However, this call for informatio
Regional Environmental Center for Central and Eastern Europe (REC), and Regional Environmental Center for Romania	The Regional Environmental Center for Central and Eastern Europe (REC) as well as its country office in Romania were contacted, but could not provide any examples of forest-groundwater PES cases. The only PES cases they were aware of related to agri-environmental PES.

Annex 3: Overview of EU policy instruments

LIFE +

The LIFE + programme (2007-2013) replaces the LIFE III programme and also the Forest Focus scheme. LIFE+ is based on three pillars:

LIFE+ Nature and Biodiversity
LIFE+ Environment Policy and Governance
LIFE+ Information and Communication.

The general objective of LIFE + is to contribute to the development, implementation, monitoring, evaluation and communication of Community environment policy and legislation as a contribution to promoting sustainable development in the EU (Commission of the EC 2004). LIFE + will support in particular the implementation of the 6th Environmental Action Programme which aims at combating climate change, halting the decline in nature and biodiversity, improving environment, health and the quality of life, promoting the sustainable use and management of natural resources and wastes and developing strategic approaches to policy development, implementation and information/awareness raising .

LIFE + supports those activities which have:

- European added value: it will intervene only where there is a clear EU value added and contributes to economies of scale on a European level.
- Leverage or multiplier effect: it will provide a co-funding mechanism with Member States, regional or local authorities and other public and private operators.
- Catalytic or demonstrative character: LIFE + will support actions that show novel ways to approach and implement environment policy.
- Long term perspective: LIFE + interventions will be investments for the future. They will aim at setting the foundations for sustainability.

Among other indicative themes such as climate change or environment and health, one proposed theme is:

Nature and bio-diversity: The NATURA 2000 network (complementary to but not over-lapping with rural development and cohesion policy instruments); the reversal of the decline in bio-diversity by 2010 and monitoring of forests and environmental inter-actions in the Community, as well as forest fire prevention measures.

LIFE + has three components:

LIFE + Nature and Biodiversity, which will:

(a) contribute to the implementation of Community policy and legislation on nature and biodiversity, in particular Directives 79/409/EEC and 92/43/EEC, including at local and regional level, and to support the further development and implementation of the Natura 2000 network, including coastal and marine habitats and species;
(b) contribute to the consolidation of the knowledge base for the development, assessment, monitoring and evaluation of Community nature and biodiversity policy and legislation;
(c) support the design and implementation of policy approaches and instruments for the monitoring and assessment of nature and biodiversity and the factors, pressures and responses that impact on them, in particular in relation to the achievement of the target of halting biodiversity loss within the Community by 2010 and the threat to nature and biodiversity posed by climate change;
(d) provide support for better environmental governance by broadening stakeholder involvement, including that of NGOs, in consultations on, and the implementation of, nature and biodiversity policy and legislation.

LIFE + Implementation and Governance, which will:

(a) contribute to the development and demonstration of innovative policy approaches, technologies, methods and instruments;

(b) contribute to consolidating the knowledge base for the development, assessment, monitoring and evaluation of environmental policy and legislation;
(c) support the design and implementation of approaches to monitoring and assessment of the state of the environment and the factors, pressures and responses that impact on it;
(d) facilitate the implementation of Community environmental policy, with particular emphasis on implementation at local and regional level;
(e) provide support for better environmental governance by broadening stakeholder involvement, including that of NGOs, in policy consultation and implementation.

This programme strand generates improvement in *the knowledge base* of environment policy development and implementation. Beside other measures, LIFE + Implementation and Governance facilitates *networking and exchange of best practice* on a European scale. Networking will be particularly important in facilitating exchanges of views and best practice in areas where policy, policy approaches, legislation or development of means of implementation are in early stages e.g. in furthering the environmental dimension of forest protection and in the forest fire prevention field.

The LIFE + Information and Communication, which will:

(a) disseminate information and raise awareness on environmental issues, including forest fire prevention;
(b) provide support for accompanying measures, such as information, communication actions and campaigns, conferences and training, including training on forest fire prevention.

In its multi-annual strategic programme the principal objective for “forests” is defined as follows:

To provide, especially through an EU coordination network, a concise and comprehensive basis for policy relevant information on forests in relation to climate change (impact on forest ecosystems, mitigation, substitution effects), biodiversity (baseline information and protected forest areas), forest fires, forest conditions and the protective functions of forests (water, soil and infrastructure) as well as contributing to the protection of forests against fires.

Priority areas of action are:

- Promoting the collection, analysis and dissemination of policy-relevant information concerning forests and environmental interactions;
- Promoting harmonisation and effectiveness of forest monitoring activities and data collection systems and making use of synergies by creating links between monitoring mechanisms established at regional, national, Community and global level;
- Stimulating synergies between specific forest-related issues and environmental initiatives and legislation (e.g. Thematic Strategy for soil protection, Natura 2000, Directive 2000/60/EC);
- Contributing to sustainable forest management, in particular, by collecting data related to the improved Pan-European Indicators for Sustainable Forest Management as adopted by the Ministerial Conference on the Protection of Forests in Europe (MCPFE) Expert Level Meeting 7-8 October 2002, Vienna, Austria; and
- Building capacities at national and Community level to allow for coordination and guidance on forest monitoring.

Rural Development Funds

The essential rules governing rural development policy for the period 2007 to 2013, as well as the policy measures available to Member States and regions, are set out in Council Regulation (EC) No. 1698/2005. Under this Regulation, rural development policy for 2007 to 2013 is focused on three themes (known as "thematic axes"). These are:

- improving the competitiveness of the agricultural and forestry sector;
- improving the environment and the countryside;
- improving the quality of life in rural areas and encouraging diversification of the rural economy.

To help ensure a balanced approach to policy, Member States and regions are obliged to spread their rural development funding between all three of these thematic axes. A further requirement is that some of the funding must support projects based on experience with the Leader Community Initiatives. The "Leader approach" to rural

development involves highly individual projects designed and executed by local partnerships to address specific local problems.

As before 2007, every member state (or region, in cases where powers are delegated to regional level) must set out a rural development programme, which specifies what funding will be spent on which measures in the period 2007 to 2013. A new feature for 2007 to 2013 is a greater emphasis on coherent strategy for rural development across the EU as a whole. This is being achieved through the use of National Strategy Plans which must be based on EU Strategic Guidelines.

This approach should help to:

- identify the areas where the use of EU support for rural development adds the most value at EU level;
- make the link with the main EU priorities (for example, those set out under the Lisbon and Göteborg agendas);
- ensure consistency with other EU policies, in particular those for economic cohesion and the environment;
- assist the implementation of the new market-oriented CAP and the necessary restructuring it will entail in the old and new Member States.

The European Agriculture Fund for Rural Development (EAFRD) is one of the two instruments financing the Common Agricultural Policy (CAP) It will finance actions in the field of rural development in the Member States in line with the rural development plans submitted by each country. The main objectives of EAFRD are:

- Improvement of the competitiveness of agriculture and forestry by supporting reconstruction, development and innovation,
- Improvement of the environment and the countryside by supporting land management,
- Improvement of the quality of life in rural areas and encouraging the diversification of economic activities.

EAFRD comprises four axes:

Axis 1 – Competitiveness

Measures aimed at promoting knowledge and improving human potential, and restructuring and developing physical potential and promoting innovation

Axis 2 – Land management

Measures aiming to improve the environment and the countryside including measures targeting the sustainable use of agricultural and forestry lands. Payment for Natura 2000 is included in this axis

Axis 3 – Wider rural development

Actions aiming to improve the quality of life in rural areas and the diversification of the rural economy

Axis 4 – Leader axis

The Leader approach is a bottom-up approach aiming to build local capacity for employment and diversification of the rural economy. It has a multi-sector design and the implementation of the strategy is based on the interaction between actors from different sectors of the local economy. Local action groups (LAGs) implement the local development strategy.

Of these, the Leader axis will contribute to the priorities of the other axes and will also play an important role for improving governance and mobilising the endogenous development potential of rural areas.

Annex 4: Groundwater ownership and compensation structure

Looking at selected countries

Based on the general overview provided in section 2, this annex shall take a closer look at 6 selected countries: Germany, Romania, Austria, Ireland, Netherlands and Czech Republic.

The main criterion for selecting these countries is their coverage of all different types of groundwater ownership: public ownership, public and private ownership, as well as no ownership. However, the countries also fulfil a number of other criteria, namely:

- Coverage of old EU member states as well as new EU member states.
- Coverage of member states following civil law and common law tradition.
- Coverage of member states which allow or do not allow certain groundwater uses without a permit.
- Coverage of member states where a part of the collected groundwater revenues is dedicated to special environmental purposes or funds.
- Coverage of member states with a majority of publicly owned forests, privately owned forests or with a distribution half-half.

Keeping in mind the very diverse picture of the member states' groundwater related legal frameworks described under section 2.2, it is important to note that no clear pattern for the fulfilment of these criteria exists. That is to say, it is for example not possible to draw conclusions for a country's groundwater ownership structure and use rights, because of its geographical location or vicinity to a country which falls under a certain group of ownership structure. The same applies with regard to the interrelation of the other criteria. For example, just because one country stipulates no groundwater ownership as well as no groundwater use without a permit, this does not mean that the legislation of another country which foresees no groundwater ownership will also reject any groundwater use without a permit.

Nevertheless, the above listed criteria have been identified as the only ones showing both, certain commonalities as well as differences among the countries. In addition, the criteria helped to select a number of countries which provide a more detailed overview of the different legal approaches and compensation structures in place.

1. Countries with public groundwater ownership structure

1.1 The case of Germany

Institutional frameworks

Since the constitutional reform in 2006 which has rearranged the different jurisdictions between the federal (national) government and the provincial states (Bundesländer), the water legislation is subject to the so called "diverging legislation".[96] This means that the provincial states are allowed to organize and broaden their own water laws even if nationwide water legislation exists. In 2009, a uniform Federal Environmental Code (Umweltgesetzbuch) is expected to be passed which will include the amended Federal Water Act as well as the Federal Forest Act.

For the time being, the national legislation regarding groundwater resources can be mainly found in the Federal Water Act (Wasserhaushaltsgesetz) which is a water framework law, in the Federal Groundwater Regulation (Grundwasserverordnung), as well as in the Waste Water Charges Act (Abwasserabgabengesetz). Within this framework, the provincial states set up more detailed and more decisive rules for groundwater use, management, monitoring and control in their State Water Acts. Regarding forestry, the Federal Forest Act (Bundeswaldgesetz) also creates only a legal framework outlining basic guidelines which need to be further specified by the states' Forest Acts. Neither the Federal Forest Act, nor the different State Forest Acts directly regulate groundwater resources. However, the protection of groundwater is provided indirectly by regulating the protection of the forest ecosystem. In addition, the Federal Soil Protection Act (Bundesbodenschutzgesetz) and the Federal Nature

[96] Art. 72 Para. 3 (5) of the German Basic Law.

Conservation Act (Bundesnaturschutzgesetz) constitute indirect protections of the groundwater resources. Finally, it should be mentioned that the administrative enforcement of the states' Water and Forest Acts is regulated by the states' Administrative Enforcement Acts.

In line with this split legal framework goes the set up of administrative responsibilities. The Federal Ministry of the Environment is not responsible for the management of groundwater resources. No uniform administrative authority is constituted at the national level. Instead, the states' water authorities supervise implementation of and compliance with the State Water Acts. Unlike the jurisdiction regarding the protection and management of the groundwater resources, the water supply and waste water disposal are core tasks of public services of general interest which fall under the municipalities' right of self-government according to Art. 28, Para 2. German Basic Law (Grundgesetz), and therefore under the competence of the municipalities. Regarding forestry, it has to be noted that the development and implementation of specific forest programs is mainly carried out by the Federal Ministry of Food, Agriculture and Consumer Protection. The states each have their own forest departments which are also traditionally connected with the agricultural sector.

Ownership and use rights

The National Water Act does not discuss the question of groundwater ownership. However, the Federal Constitutional Court (Bundesverfasssungsgericht) decided that due to its importance for the common welfare, groundwater is a vital good which is not subject to a regime under private law but under public law.[97] In line with this decision, some states explicitly regulate groundwater ownership in their Water Acts. The Bavarian Water Act and the Water Act of Baden-Wurttemberg, for example, regulate that the land owner does not own the groundwater resources under his property.[98] The Water Act of Lower Saxony stipulates that the land owner is not allowed to charge fees for the use of the groundwater under his real estate, or to use the groundwater without authorization by the Federal Water Act. As a consequence, according to German legislation, the groundwater resources are under public ownership. Their use requires a permit or license[99], unless otherwise specified by the Federal Water Act.

Such an exception can be found in § 33 Federal Water Act. According to § 33 (1), no permit or license is generally required for the abstraction, delivery or conveyance to the surface, or diversion of groundwater, if it is

- For domestic purposes, farming purposes, watering cattle outside the farm or for use in small quantities for temporary purposes[100];
- For the normal drainage of land used for agricultural, silvicultural or horticultural purposes; and
- The uses are not likely to cause significant adverse effects on the status of the water body.

However, in accordance with § 33 (2) Federal Water Act, the states may also stipulate in general or for specific areas that a permit or license is required for such domestic or small quantity use of groundwater resources.

In addition, it must be noted that water protection areas may be designated which can limit forest land owners in the use of their properties, or even lead to expropriation.[101] In the first case (e.g., prohibition of specific fertilizers), the forest land owner is entitled to receive an adjustment, but only if the requirement of "proper silvicultural use" is fulfilled. In other words, not every limitation of forest land use in a water protection area will lead to an adjustment. In case of an expropriation, an indemnification will be paid by the state.[102] The procedures and the amount of adjustment or indemnification are regulated in the states' Water Acts.

[97] "Nassauskiesfall", BVerfGE 58, 300 (330ff.).
[98] Art. 4 Para. 1 of the Bavarian Water Act and § 12 of the Water Act of Baden-Wurttemberg.
[99] A permit does not constitute a right but an authorization to use the water under public law. Rights of a third party are not affected by the permit. The permit is revocable at any times.
In contrast, a license constitutes a public right and forms the stronger legal position. The license is revocable only under certain conditions specified in the Federal Water Act.
[100] The use in small quantities for temporary purpose means the use of groundwater for a limited time and without a long-lasting purpose (e.g., groundwater pumping within the context of a trial drilling). The regular use or also the use in irregular intervals (e.g., sprinkling from time to time) does not fall under the scope of this provision.
[101] § 19 (1) Federal Water Act.
[102] § 19 (2) Federal Water Act.

If a permit or license is required for groundwater use, the states decide upon their granting. A permit or license is usually only granted, if certain management objectives are fulfilled.[103] Normally, the groundwater resource has to be managed in a way that any adverse changes to its quantitative and chemical status are avoided. The issued permits and licenses are recorded in the water registers. The competences for issuing permits or licenses are divided among the Supreme, Upper and Lower Water Authority. In the state of North-Rhine Westphalia, for example, the Supreme Water Authority is the Ministry of Environment, Land-use Planning and Agriculture of North-Rhine Westphalia, the Upper Water Authority can be found in the District Government (Bezirksregierung), and the Lower Water Authority in the Country (Kreis und kreisfreie Städte). In general, the Supreme Water Authority is responsible for granting permits or licenses in cases of possible serious impacts on the groundwater body (e.g., the granting of groundwater use rights to operate a nuclear power plant).[104]

In contrast to the German ownership structure regarding groundwater resources, German forests are almost half and half under public and private ownership. Public forest owners can be the national government, the provincial states, or the local authorities. As mentioned before, according to § 33 (1) Federal Water Act, groundwater may be used without a permit or a license for the normal drainage of land used for silvicultural purposes. Apart from that, the specific groundwater use rights of forest owners are limited in respect to the groundwater resources under their land. Instead, forest owners are obliged to properly and sustainably cultivate their forests. According to § 11 Federal Forest Act, all forest owners (public and private) are obliged to re-afforest clear-cut parts of their forests.

Compensation structure

Fines paid for violations of the Water Acts, as well as different kinds of fees, for example for abstraction or waste water, build the compensation structure for groundwater uses. As mentioned before, in Germany, water supply and wastewater disposal are core tasks of public services of general interest within the competence of the municipalities. The private user of a water supply and distribution facility pays a fee for the water supply according to the charter of the local water supply company. In Germany, water supply companies can be organized as either public or private entities. In the latter case, the local authorities are usually involved in the private corporations as indirect stockholders. Further abstraction fees can be levied on non-domestic users, i.e. industrial or agricultural users.

In addition to this general fee for water supply, some states regulate the payment of a “Waterpenny” (Wasserpfennig) which is a special fee charged for stipulated uses of the groundwater. For example, § 17a Water Act of Baden-Wurttemberg regulates that a fee is imposed for the abstraction, delivery or conveyance to the surface or diversion of groundwater, as long as § 33 Federal Water Act is not applicable. This Waterpenny is charged by the state of Baden-Wurttemberg. Another example is the state of Hessen where the use of groundwater is charged with an extra fee that is used for water related purposes.

Furthermore, local authorities and collectives (Abwasserzweckverbände), as well as business enterprises pay fees for their waste water discharge. These fees which are collected by the state affect only direct dischargers. According to the Waste Water Charges Act, the revenues collected from the local authorities, collectives and business enterprises have to be applied for special waste water related purposes, for example for supporting investments in municipal waste water treatment plants. It is important to note that the local authorities or collectives in charge of organizing the waste water disposal usually allocate their waste water fees to the land owners using the waste water sewage system. The users are charged according to the Act Regulating Municipal Fees (Kommunalabgabengesetz). In addition, their connection to the waste water sewage system is charged with an additional fee stipulated in the local waste water charters. Finally, the installation costs for the pipeline connecting to the local sewer have to be paid by the land owner.

In general, the German fee rates depend on the source of water, groundwater use being usually higher charged than surface water use, the type of water user (industrial water users facing lower rates than domestic users or small enterprises), as well as the purpose for which water is used (e.g., irrigation is subject to lower rates).[105] The abstraction fees are levied on the amount of water abstracted, while the rate of the waste water fees is based on the degree of waste water toxicity.

[103] § 33 a Federal Water Act
[104] See for example § 96 Water Act of Baden-Wurttemberg.
[105] Pierre Strosser and Stefan Speck: Environmental taxes and charges in the water sector. A review of experience in Europe.

1.2 The case of Romania

Institutional frameworks

In Romania, the Water Act of 1996 as well as the Environmental Protection Act of 1995 can be named as the core laws related to water issues. While the Water Act includes provisions related to the management, ownership, use and control of water resources, including groundwater bodies, the Environmental Protection Act introduces principles of environmental law (e.g., sustainable development, or the polluter-pays principle), shows ways to implement these principles, and regulates general issues which apply to all environmental matters (e.g., public participation, or access to information). These laws which are established through acts of parliament provide a general framework for more detailed regulations for the protection and conservation of water resources. Such implementing legislation in the form of orders (e.g., Order 148/1997 regulating the procedures and requirements for granting water permits), decisions or guidelines together with the Water Act and the Environmental Protection Act build the groundwater related legal framework.

Regarding forestry, in Romania the management of all forests is done according to the Forest Act (Law 26/1996). As an important provision Art. 17 of the Forest Act can be cited which states the need for the elaboration of forest management plans which shall aim at ensuring the continuity of the forests' ecological and socio-economical functions. Apart from the Forest Act, again the Environmental Protection Act as the environmental framework law, Law 1/2000 regarding the reconstitution of the ownership right over agricultural and forest lands and the Hunting Act as an indirectly relevant law have to be named in order to describe the forest related legal framework.

Management of water resources is a responsibility of the national government. The jurisdiction over groundwater resources is divided between the Ministry of Environmental and Water Management, the National Water Authority called "Apele Romane", and the local Environmental Protection Inspectorates. The Ministry of Water and Environmental Protection is amongst others responsible for the development of the administrative process regulating water uses through a license and permit system. Under the local Environmental Protection Inspectorates' jurisdiction the licenses and permits are granted to the user in a close collaboration with the river basin and provincial offices of Apele Romane. In addition, the local authorities are responsible for the drinking water supply, the waste water disposal and treatment. The monitoring of groundwater, however, is again the duty of Apele Romane.

Forestry falls under the jurisdiction of the forestry department in the Romanian Ministry of Agriculture, Forests and Rural Development, and the National Forest Administration (ROMSILVA). The forestry department is responsible for the development of forest policy and legislation governing operations on all forest land. It is also responsible for forest management control on privately-owned forest land. ROMSILVA is responsible for managing state forest land, under policy and legislative direction from the forestry department. It implements the national strategy in the field of forestry and operates with protection, preservation, nature tourism and sustainable development issues. It is financially autonomous, but can receive some public funds, mainly for forest road construction and reforestation activities. ROMSILVA is also responsible for the Institutul de Cerccetari si Amenajari Silvice (ICAS), which is in charge of research and forest management planning.[106]

Ownership and use rights

The ownership of groundwater is regulated straight forward in the Romanian Water Act. According to Art. 3 (1) of the Water Act, the public domain shall own the surface waters as well as the groundwater resources. Thus, in Romania groundwater resources are clearly under public ownership.

In contrast to this public groundwater ownership structure, according to Art. 4 of the Forest Act, all Romanian forests are under public or private ownership. It is important to note that a forest land restitution process has been ongoing over the last years which aims at returning forests back to ex-owners. Private forest ownership is estimated to be around 20 % of the total forest area, however, further increasing.[107]

[106] A. Mitchell, S. Poynton, I. V. Abrusan, G. Ionascu: Situation of the Forestry Sector in Romania, at www.fao.org/DOCREP/004/X4009E/X4009E13.htm .
[107] F. Hirsch, A. Korotkov and M. Wilnhammer: Private forest ownership in Europe, Unasylva 228, Vol. 58, 2007.

The Romanian Water Act foresees both possibilities of groundwater use: use with and without a permit. The use without a permit is called free use of groundwater under Art. 9 Para. 2. of the Water Act. This provision stipulates that groundwater may be freely used

- For drinking, watering, washing, bathing and other household needs; and
- If no installations, or low capacity installations are used of less than 0.2 liter/sec; or
- For exclusively meeting the needs of one's own household.

According to Art. 9 Para. 1. of the Water Act, any other use not covered by Para. 2., requires a water management license. Such a license is also needed for discharging waste water and draining water from mines and deposits into water bodies. The licenses are issued only for a limited time, at most for five years. Afterwards, the water user has to reapply for a new license. It is interesting to note that according to Art. 10 (1) of the Water Act, the population's water requirements are given priority over the use of water for other purposes. Also, priority over other water uses is given, for example, to the flows required to maintain the ecological equilibrium of the aquatic habitat. It could be argued that this latter provision can also apply and give priority to the maintenance of groundwater bodies, since they are important for the ecological equilibrium of aquatic habitats.

Furthermore, Art 30 Para. 1. of the Water Act states that planting or cutting down trees or shrubs on the land located in the major watercourse beds is forbidden without a water management permit and the agreement of the specialized forestry bodies. Special functions of the forest related to water resources are determined in Art. 31 of the Water Act. This provision acknowledges that forests in the reception basins of the reservoirs, those in basins of high torrential degree and prone to erosion, in major river beds, in the dam-bank areas, as well as the forest belts located along undammed rivers belong to the group of forests with special water protection functions. Therefore, they shall be managed as such, through intensive treatments and by forbidding clear-cuttings or short-time regenerating treatments.

The licenses to use groundwater resources are granted by the local Environmental Protection Inspectorates. Only in special cases the Ministry of Environment is responsible for the granting of licenses. This is the case, for example, for certain works related to afforestation and deforestation of the wooden vegetation, Art. 48 Para. 1. h), Art. 50 of the Water Act.

Apart from the Water Act, the Forest Act also includes regulations that address both, forest and groundwater resources. Especially Art. 13 of the Forest Act has to be mentioned according to which natural and legal persons as well as public institutions who benefit economically from the effects of forest protection functions shall have the obligation to pay to the forest units the equivalent value of these effects.

Compensation structure

The compensation structure for the water use in Romania is divided into three different fees:

- The water extraction fee which is calculated by quantity of used water;
- The discharge fee which is imposed for the waste water discharge into water bodies; and
- The water consumption fee which covers the operating costs of the water supply company.

Furthermore, penalties are levied for non-compliance with the standards, for both water intakes and discharges of waste water, which can amount to 200 % of the normal charge rate.[108]

The revenues are collected by Apele Romane which is responsible for administering the national water management system as well as authorizing the water abstraction and waste water discharge. The revenues collected through the fees are used to cover the Apele Romane's operating costs. The funds collected through the non-compliance fines are dedicated to the Water Fund and used to support investment in raw water supply, etc.

Apart from this already existing compensation structure, Art. 13 of the Forest Act provides an interesting provision which could serve as a basis for the establishment of future payment for environmental services schemes in

[108] Pierre Strosser and Stefan Speck: Environmental taxes and charges in the water sector. A review of experience in Europe.

Romania. As mentioned before, according to Art. 13 natural and legal persons as well as public institutions who benefit economically from the effects of forest protection functions shall have the obligation to pay to the forest units the equivalent value of these effects. Order 625/06 issued by the Ministry of Agriculture, Forests and Rural Development has already established the calculation methodology for such compensation schemes which allow forest owners to be paid for their environmental services (special protection functions), mainly regarding the hydrographical balance. However, in the course of this study, it was not possible to find sufficient information which could prove the actual implementation of Art. 13 of the Forest Act and the development of such a compensation scheme.

2. Countries with public and private groundwater ownership structure

2.1 The case of Ireland

Institutional frameworks

In Ireland, the groundwater related legal framework comprises a number of laws that need to be taken into account: the Water Services Act of 2007, the Local Government (Water Pollution) Acts of 1977 to 1992, the Environmental Protection Agency Act, the Protection of the Environment Act of 2003, the Constitution of the Republic of Ireland as well as the European Communities (Good Agricultural Practice for Protection of Waters) Regulation of 2006. Furthermore, being a common law country, in addition to the legislation in place case law provides an important legal source for further guidance and regulation.

The main Irish forest legislation consists of the Forestry Acts of 1946, 1956, and 1988, the Local Government (Planning and Development) Acts of 1963 to 1992 in relation to the making of Tree Preservation Orders by local authorities, as well as the Wildlife Act of 1976.

The Water Services Act confers powers on authorities to abstract waters for the purpose of providing water supplies. The Water Pollution Acts and the Environmental Protection Agency Act regulate the use of groundwater resources for discharging waste water as well as related offences. Furthermore, they regulate the monitoring and control of groundwater resources. The ownership of groundwater resources, however, is not determined by any of these water laws. Instead, the Irish Constitution and the common law are applicable.

The jurisdiction over groundwater resources is divided among the Ministry of Environment, the Environmental Protection Agency as well as the local authorities. While the Ministry of Environment is in charge of developing and implementing government policies, the Environmental Protection Agency executes the national “WFD Groundwater Monitoring Program” which aims at assessing the general state of groundwater quality and groundwater levels in Ireland. The monitoring data are used to help determine the status of groundwater and to protect particularly those groundwater resources used for public and private drinking water supplies. In addition, the Environmental Protection Agency is responsible for prosecuting violations of licensed activities. The local authorities again are primarily responsible for providing water and sewerage services, ensuring the prevention, protection and improvement of water quality as well as carrying out the water monitoring. In addition, they create water management plans.

The Forest Service, a division of the Department of Agriculture, Fisheries and Food, has overall responsibility for forestry development in Ireland, including the national forestry strategy.

Ownership and use rights

As noted above, the ownership of groundwater is regulated by the Irish Constitution which establishes the common law tradition. As a consequence, the general common law rule applies according to which the owner of a land owns the resources underneath it, including the groundwater. Thus, in Ireland, the groundwater resources are publicly or privately owned.

Just like the groundwater resources, forests can also be under public or private ownership. Less than one third of the forest is in private hands. Some 70% of the Irish forest is owned by Coillte Teoranta, a state owned commercial forest company.[109]

The abstraction of groundwater resources generally requires a permit by the local authority. However, an exception is made for domestic use of the groundwater resources. According to Section 105 (12) of the Water Supply Act 2007, domestic water use is defined as including the following purposes:

- Drinking,
- Washing,
- Heating, and
- Sanitation.

At the same time, certain uses are expressly excluded, namely:

- Agriculture or horticulture,
- Any trade, industry or business,
- Any purpose incidental to a household or private garden (including washing a private vehicle) if the water is drawn otherwise than from a tap inside the household or if a hosepipe or similar apparatus is used,
- Central heating other than central heating of a household,
- Apparatus depending while in use upon a supply of continuously running water, not being an apparatus used solely for heating water.

The discharge of water is also generally prohibited without a license, Section 4 (1) of the Water Pollution Act. Nevertheless, the law also foresees certain exemptions which are defined in Section 4 (2) of the Pollution Act. According to their jurisdiction, the Environmental Protection Agency or the local authorities decide upon the granting of licenses regarding water pollution.

Groundwater related rights of forest owners are to be found in the "European Communities (Good Agricultural Practice for Protection of Waters) Regulations 2006". In this regulation forestry is subsumed under the term "agriculture". In consequence, the prohibitions established regarding the pollution of waters are also applicable to forest owners.

Further forest provisions which can be relevant for the management of groundwater resources can be found in the 1946 Forestry Act. According to the 1946 Forestry Act, landowners are required to give notice of intention to fell trees, following which Prohibition Orders are normally served. These remain in force pending the issuing of a Limited Felling License, which can include environmental and replanting conditions. General Felling Licenses are normally granted to large estates where a management program is in place, or for lands where scattered trees must be cleared in order to enable new planting or for silvicultural thinning.

Finally, it is interesting to note the existence of two schemes established by the Forest Service:

- Rural Environment Protection Scheme (REPS) which shall encourage farmers to enhance the environment through a range of actions including reduced use of fertilizers and pesticides contributing to improved water quality. The scheme also assists in maintaining existing hedgerows and planting new ones.
- Forest Environmental Scheme (FEPS) which shall encourage the establishment of high nature forestry on farms participating in REPS.

As a consequence, in the case of FEPS under REPS, a link between forest and groundwater can be established.

Compensation structure

Water supply is either organized by the public authorities (particularly in urban areas), or through group water schemes. The latter are found in rural areas which lie outside the scope of the urban public mains systems

[109] See Pelkonen, P., A. Pitkänen, P. Schmidt, G. Oesten, P. Piussi, and E. Rojas (2000): Forestry in Changing Societies in Europe. Study Book Part II: Country Reports.

administered by the local authorities. Group schemes, which consist of two or more houses, can be private or public depending on their source of water, namely whether their water is supplied from the public mains (public group water scheme) or a private source (private group water scheme).

In line with international practice and emerging EU policy Ireland is moving towards making the full cost of water and waste water services to all sectors transparent, and securing full cost recovery in the case of non-domestic users. To facilitate this, a policy framework has been developed to comprehensively apply the polluter pays principle in regard to water services infrastructure and operations. This framework provides for:

- Collection of capital contributions by local authorities from non-domestic users in accordance with the polluter pays principle.
- Full recovery of operational costs in respect of the non-domestic water and waste water services to users.
- Metering of all non-domestic users.
- Connection fees for water supply and sewerage connection.
- Funding of the cost of providing water and waste water services to domestic users through the capital budget and, in the case of operational costs, through the Local Government Fund.

As listed above, all water charges for domestic use in urban areas were abolished in 1997 (see Art. 105 (1) Water Services Act of 2007). Since then, the common water supply is free of charge for domestic use. Only industrial users are obliged to pay fees for their water supply. These fees are determined by the corresponding local authorities and can be either based on the estimated consumption or metered.

Within group water schemes, fees apply also to domestic water uses. Local authorities provide a subsidy for each house in a private group scheme just as they do for the public group scheme members. However, the subsidy for a private group scheme is higher to reflect the increased costs associated with a private water supply, such as filtration and disinfection costs.

The water charges are used specifically to maintain and improve the water and waste water systems.

Finally, at least a basis for a forest-groundwater related payment for environmental services scheme exists in Ireland. This would be the case insofar as payments under FEPS lead to the establishment of forestry on farms participating in REPS, which again enhance the environment through improved water quality. In other words, in such a case, payments would be made to forest owners to protect groundwater. However, within the course of this study, no evidence for such payments could be found.

2.2 The case of Austria

Institutional frameworks

In Austria, the Federal Water Right Act contains the basic regulations on water management, ownership, use and control of groundwater resources and the compensation structures for the use of groundwater. Also, penalties and fines regarding offences against the water law are regulated in the Water Right Act. Further basic groundwater dispositions are set out in the Groundwater Protection Regulation and the Water Charges Act. Additionally, provisions regarding groundwater resources are included in the forest laws. The basic forest related legislation is contained in the Federal Forest Act of 1975. Other legislation with relevance to forests includes the Regulation on Forest Development Plans. Also, the provincial states (Bundesländer) have adopted relevant forest legislation. It is interesting to note that although Austria is organized as a federal system, no provincial water laws exist in addition to the national water law, as it is the case of the German federal system.

According to § 98 of the Federal Water Right Act, the Federal Ministry of Agriculture, Forestry, Environment and Water Management, the Provincial Governors (Landeshauptmann/-frau) and the District Administrative Authorities are responsible for the execution of the Water Right Act, as well as for monitoring its implementation. In general, the execution of the national water law falls under the responsibility of the states. The Provincial Governor or the District Authorities have the competence to supervise the groundwater quality. However, the Federal Ministry of Agriculture, Forestry, Environment and Water Management can, under certain conditions, develop framework regulations for certain (ground-)water areas. Water supply and sewerage is again the responsibility of the local authorities.

The implementation and execution of the State Forest Acts is responsibility of the State Governors and the District Authorities.

Ownership and use rights

In Austria the groundwater resources are divided into public and private water bodies, § 1 Federal Water Right Act. According to § 3 Para. 1 (a), the proprietor of a real estate is the owner of the groundwater resource underneath the property, unless another person already holds a specific ownership right to the groundwater.

The ownership of forests, like the one of groundwater, can be public or private. The majority of the Austrian forests are in private hands (ca. 80%).[110] The major part of the rest is owned by the federal state, and only a small percentage belongs to the provincial states and communities.

Despite being the owner of a groundwater resource, the real estate owner is still limited in his rights regarding the groundwater as it is considered part of the public good. Not only does he require a permit for larger extractions of groundwater. Also, ownership rights can be impaired, inter alia, by expropriation (§§ 63 – 70 of the Federal Water Right Act) or by the declaration of a private water body to become a public one (§ 61 Para. 1 of the Federal Water Right Act). The latter is possible for the sake of the public interest and with the agreement of the Federal Ministry of Agriculture, Forestry, Environment and Water Management. As expropriation qualifies the significant modification of groundwater conditions which may be allowed for water facilities which serve the public interest.

As for the permit requirement, the following applies: § 9 of the Federal Water Right Act determines that groundwater use generally requires a permit. However, according to § 8, public groundwater can be used without a permit, if the use qualifies as “ordinary use”. That is the case if

- No specific devices are utilized,
- The equal use by others is not being compromised, and
- The character of the water is not endangered, no one is harmed, legitimate rights are infringed, and the public interest is not affected.

As private groundwater resources are concerned, § 10 of the Federal Water Right Act foresees that the real estate owner may extract his groundwater without a permit, if

- Such use is necessary for household or business use,
- The abstraction is carried out only by a manual pump or in adequate relation to the size of the property, and
- The use does not interfere with other legitimate use rights.

This kind of subsistence groundwater extraction is frequently made use of. In Austria, around 1 million people (13%) are not connected to the public water supply, but instead receive their water from private wells.[111] The authority responsible for issuing water use permits, i.e. generally the District Authority, needs to ensure that the use right applied for does not run contrary to the public interest and that existing rights are not infringed upon. If a permit is granted, the licensee is obliged to abstain from polluting the groundwater.

The Federal Forest Act also foresees the protection of groundwater resources. According to § 5 of the Federal Forest Act, the Austrian Federal Forest Inc. (Aktiengesellschaft zur Fortführung des Betriebes „Österreichische Bundesforste“), which is established by the Act, has to serve the purpose of conserving the drinking water resources.

[110] See Pelkonen, P., A. Pitkänen, P. Schmidt, G. Oesten, P. Piussi, and E. Rojas (2000): Forestry in Changing Societies in Europe. Study Book Part II: Country Reports.
[111] Source: Austrian Ministry of Agriculture, Forestry, Environment and Water Management, at http://wasser.lebensministerium.at/article/articleview/60323/1/1459/.

Forest owners are obliged to properly and sustainably manage their forest. They are not allowed to clear-cut the forest in a way that affects the water household or the forest soil significantly or permanently and must re-afforest clear-cut areas within a timeframe of five years.

As the Federal Water Rights Act stipulates that direct or indirect impacts on the groundwater constitution require a permit, forest owners might also be obliged to apply for such a license if certain run-offs of their forest areas influence the groundwater quality. However, correct silvicultural practices are presumed not to have an impact on the groundwater unless the contrary is proven. Therefore, as long as the forest owner acts in compliance with relevant regulations, such as those on the use of chemicals, fertilizers, and forest management, they are not required to obtain a groundwater use permit, § 32 of the Federal Water Right Act.

Finally, it is important to mention that the Federal Ministry of Agriculture, Forestry, Environment and Water Management can, under certain conditions, develop framework regulations for certain (ground-)water areas by which the water is, for example, dedicated to a special purpose, or the issuance of water permits is be limited. Additionally, according to § 32 Para. 2 of the Federal Water Right Act, the states can adopt ordinances relating to the declaration and management of water protection areas. Those groundwater areas as well as water protection areas can, of course, be established on forested land.

Compensation structure

In Austria, approximately one million people receive their water from their own well or from cooperative societies and more than 2 Million people are served by small water suppliers. Only two large water suppliers (among them the public services of the city of Vienna, Stadtwerke Wien) exist.

According to the Water Charges Act, the municipalities set their own water charges for which an upper level is set by the Distribution of Funds Act. In all municipalities the water charges consist of several elements: As in the other member states, groundwater related fees are charged for the abstraction as well as pollution of the water resources. Both fees are calculated per volume. In addition, fees are charged for the renting of the water meter which again depends on the amount of water consumption, and for the connection to the public water supply system. Finally, no direct eco-tax exists in relation to water.[112]

As mentioned before, water supply and sewerage are the responsibility of the municipalities. These can, in order to fulfil their tasks more efficiently, organize themselves in public corporations (cooperatives and associations), §§ 73-97 Water Right Act. Also, water supply companies can be either established in public or in private form. However, private water supply companies are less common.

The water charges are paid to the municipalities where the revenues go to the general budget. While a budget for water provision exists within the general budget, it is also possible that funds are transferred from other public service budgets to the water service budget and vice versa. Furthermore, it is important to notice that in Austria, the water charges are no longer earmarked.

3. Countries with no ownership of groundwater resources

3.1 The case of the Netherlands

Institutional frameworks

The groundwater related legal framework in the Netherlands basically comprises the following laws: the Groundwater Act, the Water Management Act, the Soil Protection Act, the Environmental Management Act as well as the Civil Code. While the Groundwater Act regulates the management, use, compensation and control of groundwater resources, the Water Management Act sets up the planning system for integrated water resources management, including groundwater management. The Soil Protection Act includes provisions which aim at protecting groundwater resources against pollution and the Environmental Management Act determines environmental quality standards. Finally, the Civil Code is relevant for the regulation of groundwater ownership.

[112] S. Mohajeri, B. Knothe, D. Lamothe, J. Faby (2003): Aqualibrium: European water management between regulation and competition.

The Dutch forests are primarily regulated by the Forest Act of 1922. Other legal provisions related to forestry can be found in the Nature Protection Act, the Landscape Act, the Land Use Planning Act and the Hunting Act.

The regulation of groundwater resources falls mainly under the jurisdiction of the Ministry of Housing, Spatial Planning and the Environment which is generally responsible for the national environmental policy. This involves specifying water quality objectives and emission standards, environmental impact assessment, drinking water, sewerage systems and land use (spatial planning). However, the administration of the groundwater tax is responsibility of the Ministry of Finance, together with the Central Environmental Tax Unit. According to the Groundwater Act, groundwater management falls under the responsibility of the provinces. These are also responsible for the implementation of groundwater management (planning and licensing) within their territory and obliged to draw up groundwater plans. The municipalities, again, are in charge of protecting the quality of groundwater against pollution, collecting waste water and providing sewerage systems.

The development and implementation of forest related policies falls under the jurisdiction of the Ministry of Agriculture, Nature and Food Quality and its Department of Nature Management. In addition, forestry policies are influenced by the Ministry of Economic Affairs which is in charge of issues related to the country's timber industry, and by the Ministry of Housing, Regional planning and Environment as far as country planning and environmental policy matters are concerned. The Dutch Forest Administration is the responsible authority for controlling, conserving and replanting the forests.

It should be noted that the Dutch water law still requires further revision in order to fully implement the WFD and its Groundwater Daughter Directive. As part of this revision, the proposal for an integrated Water Act has emerged which will replace the Groundwater Act and the Water Management Act. It is planned to attribute to the provinces only the regulation of large-scale groundwater uses (abstractions), whereas the local water authorities would manage and regulate all other uses except the protection of groundwater quality.

Ownership and use rights

According to the Dutch Civil Code, groundwater resources are a so called "res nullius" before they come to the surface. That is to say, groundwater is not subject to any kind of ownership as long as it is still located underground. However, according to Article 5:20 (c) of the Civil Code, once the groundwater comes to the surface through springs, wells or pumps, it is owned by the owner of the land where it appears even when the groundwater comes from beneath the ground of other land owners.

As far as forests are concerned, both public and private ownership is possible. About 40 % of the Dutch forests are owned by private owners, ca. 11 % belong to nature conservation organisations, and the rest is owned by public entities, i.e. the state, provinces, municipalities, and public organisations such as water supply companies.[113] The forests are open to the general public for recreational purposes.

In general, the use of groundwater resources requires a permit. Extracting groundwater from or infiltrating water into a groundwater body is forbidden unless a permit is granted by the provinces. However, the extraction of small amounts of groundwater by certain individuals determined by law is generally not subject to a permit. Instead, the provinces may decide to replace the permit requirement with general rules. This also means that the use of such small quantities of groundwater must only be registered with the competent authority and not follow the regular licensing procedure which applies to larger groundwater extractions.

The province keeps a record of the permits and of the water use so it can keep an overview of all abstractions in order to ensure that not too much groundwater will be abstracted. The conditions for granting use rights are that the use and quality of the water is monitored and reported to the province and that there is no risk of groundwater pollution. When a lack of groundwater exists, important abstractions have prevalence over less important abstractions; for example, drinking water takes priority over agricultural use.

The Soil Protection Act and the Environmental Management Act both contain the general duty to take care of the soil and the environment, including by not polluting it. The Groundwater Act contains a duty of land owners above

[113] See Pelkonen, P., A. Pitkänen, P. Schmidt, G. Oesten, P. Piussi, and E. Rojas (2000): Forestry in Changing Societies in Europe. Study Book Part II: Country Reports.

groundwater to accept research and the abstraction of groundwater resources by license holders. Groundwater abstraction licenses are not limited in time, but also not transferable. Those who suffer damages through the groundwater extraction have no possibility to appeal against the license but can only claim compensation.

Forest owners do not have any particular rights with regard to the groundwater resources found on their property. If the forest is a protected area, however, it may have a special position on the national drought series to protect it against droughts. This special position on the drought list requires a person interested in abstracting groundwater to apply for a license which takes the possible impacts of the groundwater abstraction on the protected area site into account.

Compensation structure

Every license holder pays a fee for the use of groundwater to the corresponding province. As only users of larger amounts of water are required to obtain a license, there is no such fee for small-scale groundwater abstractions. The province must use the fee for special purposes, including the research of groundwater and the maintenance of the groundwater monitoring network, for compensation for damages caused by groundwater related activities, and for the restoration of damaged nature as far as the damage is related to groundwater extraction.

Additionally, in 1995 a groundwater tax was introduced with the objective of generating revenues, as well as to protect the groundwater resource which is the source of 70 % of the total Dutch water supply.[114] The tax applies to the abstraction of groundwater by water works or by other entities, e.g. industrial and agricultural self abstractors. Payments are based on the actual consumption. Tax exemptions are foreseen for a number of cases, including for small amounts of extracted groundwater, for groundwater used for emergency purposes or environmental reasons, and for watering and irrigation in the agricultural sector. The tax is paid to the national government, via the Ministry of Finance, and goes to the general financial household of the Netherlands. As a consequence, the so collected revenues do not need to be spent for any special purposes.

Direct discharge of polluting substances in groundwater is forbidden unless a license based on the Environmental Management Act is obtained. There is no special fee for discharges (direct or indirect) into groundwater. This is different from discharges into surface waters, where a fee must be paid for all discharges.

The competent authority that issues the permit collects the fee for its issuance and keeps it. The revenues are dedicated to the costs incurred by the competent authority for its due care for the good quality and quantity status of groundwater. In case the extraction or infiltration causes damage to property (ground or buildings et cetera), the permit holder is liable for damages (see also above). Conversely, if the extraction or infiltration permit is withdrawn, the State can be liable for damages in accordance with the principle of *égalité devant les charges publiques*.

3.2 The case of the Czech Republic

Institutional frameworks

The main legal text regulating groundwater in the Czech Republic is the Water Act of 2001 which regulates in detail the management and use rights related to groundwater. Responsible for the adoption of decrees on groundwater related issues is the Ministry of Agriculture which has to act in cooperation with the Ministry of the Environment.

The execution of the Water Act falls under the competence of the Czech Environmental Inspection and the water authorities. The latter are especially regional and municipal authorities, but also the Ministry of Agriculture as the central water authority.

With regards to forestry, the main law is the Forestry Act of 1995. Other important laws include the Act on Nature and Landscape Protection of 1992, the Law on Integrated Prevention and Reduction of Pollution, the Act on Trading in Forest Reproductive Material, and the Game Management Act.

[114] Pierre Strosser and Stefan Speck: Environmental taxes and charges in the water sector. A review of experience in Europe.

The state forest administration is carried out by the Ministry of Agriculture and district offices. The Ministry of Agriculture is the central body of the state forestry administration. It is responsible for a number of tasks, such as making decisions on the classification of protection forests and so called special purpose forests, permitting activities with an impact on such land which is designated for the fulfilment of forest functions, or commissioning and approving regional plans of forest development. The district offices are in charge of, for example, designating land for the fulfilment of forest functions, or granting of exemptions from the prohibition of certain activities in the forest. The Ministry of the Environment, as the supreme state supervisor, is responsible for monitoring compliance by state administration bodies, individuals and legal entities with the forest legislation. However, according to Art. 29 Para. 3 (l) and Art. 51 Para 1 of the Forestry Act, monitoring compliance with the forest legislation is also part of the mandate of the Ministry of Agriculture. In this context, the Forestry Act does not clearly distinguish the responsibilities of the Ministry of Agriculture and the Ministry of the Environment with regard to monitoring compliance.

Ownership and use rights

According to Section 3 of the Water Act, "surface water and groundwater are not subject to ownership and do not constitute a part or appendage of the plot of land on which or under which they occur". Thus, there is no ownership over groundwater. Instead, it is considered as a *res nullius*. Forests, however can be in public as well as private ownership.

According to Section 8 (1) of the Water Act, a permission is required for any kind of groundwater use, including groundwater withdrawal and the discharge of waste water into groundwater. Very few exceptions to the permission requirement are made under Section 8 (3), such as

- Short-term pumping tests in hydrogeological research,
- Withdrawal of the water for assessing its status, and t
- Single withdrawal in case of rescue work in accidents, fire or other natural disasters.

Thus, in contrast to most other EU member states, small-scale domestic groundwater use is not allowed without a permit.

Groundwater resources are, according to Section 29 of the Water Act, primarily reserved to ensure drinking water supply for the public and for purposes in which the use of drinking water is required by a special legal regulation. Therefore, other uses may only be allowed if such use is not to the detriment of the above need's satisfaction.

Regarding the interrelation between forests and groundwater resources Sections 28 – 33 of the Water Act play a key role. Section 28 foresees the possibility of designating so called Protected Areas of Natural Water Accumulation which can be established by governmental decree. Such protected areas concern areas which, as a result of their natural conditions, form significant natural water accumulation. Under Section 28 (2), it is expressly stipulated that in the Protected Areas of Natural Water Accumulation it is forbidden to reduce the size of forest land and to drain forest land.

Apart from the Protected Areas of Natural Water Accumulation under Section 28, Section 30 of the Water Act allows the determination of Protected Zones of Water Resources. These protected zones can be established by the responsible water authority in order to ensure the protection of the yield, quality and wholesomeness of groundwater that is used for drinking water. It is important to note that in both cases, the owners of the affected lands are entitled to compensation insofar as they suffer damages as a result of the protection of their ground.

The Czech Forest Act expressly states under Art. 20 Para. 1 (m) that nobody may disturb the water regime. In addition, the Forest Act requires forest owners to carry out forest management in cooperation with specifically trained forest managers and keep a forest management record. When working in the forest, owners are required to use environment friendly, biodegradable oils, engine oils and hydraulic liquids, Art. 32 Para. 8 of the Forest Act. Additionally, reclamation and torrent control, i.e. measures aimed at the protection of soil and care for water management conditions, fall under the obligation of the forest owner unless the relevant state forest administration decides to take this on in the public interest, Art. 35. In the latter case, the owner is obliged to tolerate these measures.

Compensation structure

The abstraction of groundwater is subject to the payment of charges, Section 88 of the Water Act. These fees are based on the actual quantity of groundwater withdrawn. However, exemptions from this abstraction fee are foreseen, such as withdrawals permitted for the purpose of gaining thermal energy, or abstraction of certain limited amounts per year or month. In addition, a fee is charged for the permitted discharge of waste water into groundwater, Section 100. For private waste water discharge, a flat rate is determined.

The water abstraction and pollution fees are payable to the municipality. They are collected by the respective territorial jurisdiction. 50% of the abstraction fee goes to the general budget of the region where the groundwater withdrawal takes place. The remainder constitutes revenue of the State Environmental Fund.

Fees which constitute revenue of the budget of the region must be used for supporting the building and renewal of water management infrastructure, or for the establishment and replenishment of a special fund which regional authorities are to establish for remedial measures in cases of serious threats of groundwater pollution. In contrast to the fees for groundwater withdrawal, the groundwater pollution fees are not earmarked for any special purpose.