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Abstract

This paper draws together the information from the sub-catchment reports undertaken in the Czech Republic, England, Finland, Greece, Norway and Scotland and shows the rationale for sub-catchment selection. It recognises the need to explore the diversity of conditions in Europe with repect to the challenges to the delivery of the Water Framework Directive and the Habitats Directive (Natura 2000). The selection of sub-catchments provides a means of exploring the challenges of cost-effective adaptation of management practices and remedial measures in knowable communities of place with specific challenges to water and habitat quality.

Our selection of case studies shows the prevalence of agricultural land use as a factor compromising delivery of Water Framework Directive and Natura 2000 objectives, but there are also other factors, such as sewage works, hydropower production, industrial demands , fish farming and recreational demands which can be important in local contexts.

We offer an overarching framework to classify the multiple demands made on the case study water bodies and use this to indicate how the choice of sub-catchments reveals both commonality and difference over space.

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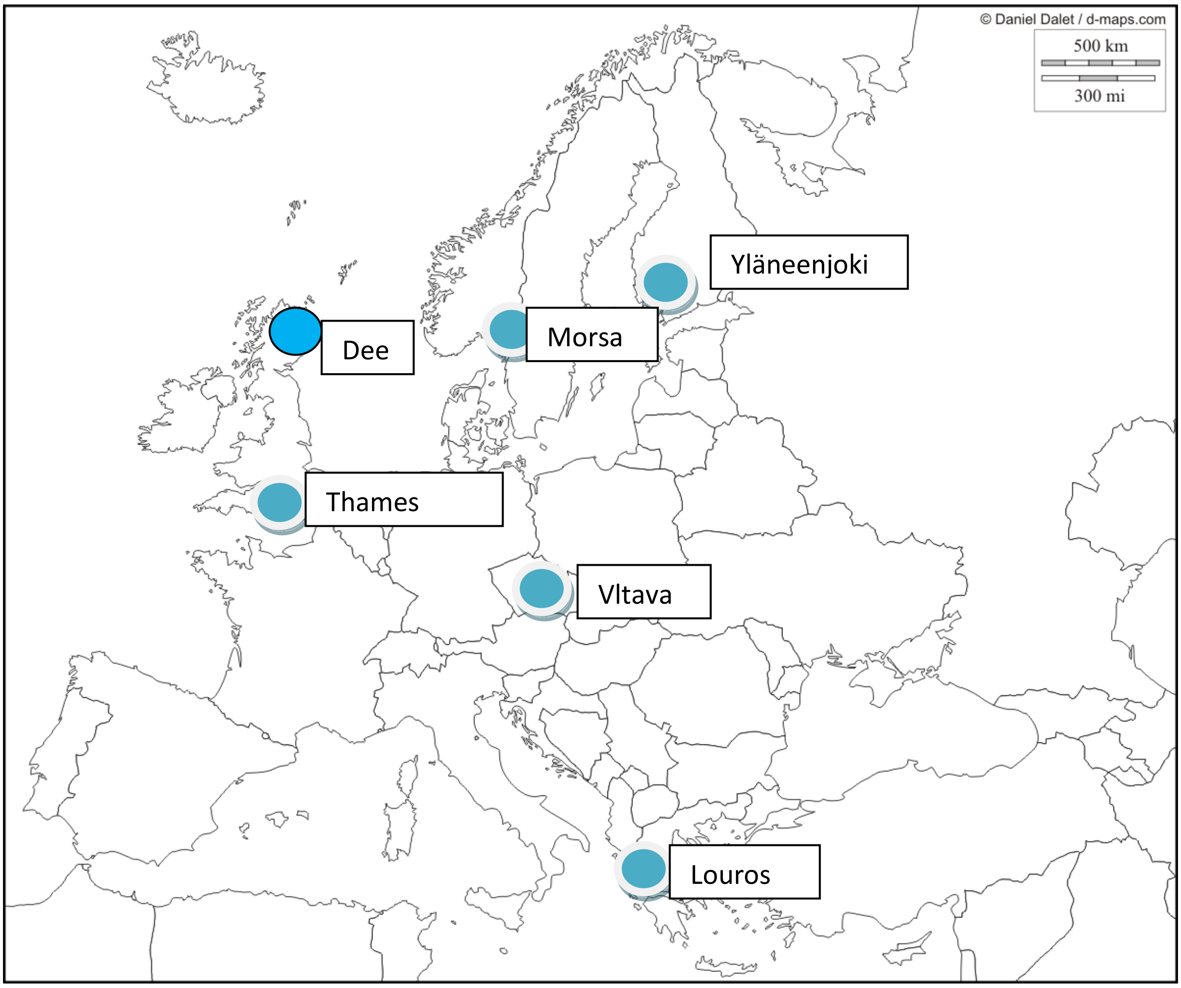
1 Introduction

This report summarises the situation in the sub-catchments of the six catchments selected for socio-economic analysis in the European-funded REFRESH project in Scotland, England, Norway, Finland, the Czech Republic and Greece. The catchments are indicated in Map 1. Three of the catchments (the rivers Dee, Morsa and Yläneenjoki) represent points on an east-west transect across temperate northern Europe near 60˚ north. Two further catchments, the rivers Thames and the upper Vltava, represent a southern UK and central Europe perspective at about 50˚ north. One catchment, the river Louros in mainland Greece, represents a southern European Mediterranean perspective at about 40˚ north.

Map 1 The location of the drainage basins for further study



Given the Europe-wide operation of the principal legislation to protect water and wetland habitats, namely the Water Framework Directive (WFD)and the Habitats Directive(HD), this part of Work-package 6 of REFRESH seeks to offer a contextual description of the sub-catchments which will be investigated in depth with regard to the cost-effectiveness of actions to enhance water and habitat quality.

We recognise that there are likely to be context-specific factors that compromise habitats and species and that inhibit the achievement of good ecological and morphological status under the

WFD and which compromise the demands of Natura 2000 (HD). The selection of sub-catchments represents an explicit attempt to accommodate the diversity of conditions, which vary in part because of biophysical differences and in part because of anthropogenic influences, the latter of which derive from institutional and policy contexts and the multiple ways in which human occupancy and use of land and water impact on water quality.

We recognise that the effective implementation of both WFD and HD is contingent on the creation of appropriate administrative structures within the respective EU member states and it is clear that the degree of preparedness to implement the WFD differs. Norway, which is not an EU member state, is implementing the EU WFD through the Agreement of the European Economic Area (EEA). Even if this has lead to extended deadlines of the Directive's objectives, the case catchment in question, Morsa, is one of 30 catchments that follow the deadlines of the EU countries. Norway is, however, not part of the Habitats Directive.

Some of our catchments have a legacy of water quality and habitat planning which extends back beyond the current European legislation. Indeed, in many cases the current legislation and intervention practices build on prior knowledge and interventions which were built up over a considerable period of time.

We also recognise that the availability of data on the factors that mediate water quality is likely to differ from country to country and catchment to catchment. Some of the catchments, in particular the three northern European catchments, have been the setting for significant long-term data collection by researchers. Some parts of the Thames have also been subject to intensive investigation.

Increasingly, an ecosystem services approach is used to explore the diversity of outputs from natural resources. As a natural resource, water experiences many (sometimes) conflicting anthoprogenic demands. These multiple demands and functions of water impact on compliance with key pieces of European legislation. In our approach to sub-catchment we have tried to recognise the multiplicity of demands on our catchments and to select sub-catchments that reflect the diversity of conditions encountered in trying to achieve compliance with Water Framework Directive and Habitats Directive requirements. Table 1 indicates a range of demands on the water system for the provision of ecosystem services and how these can impact on WFD/Natura 2000.

Table 1 Demands for water system ecosystem services

Use/demand on water system	Example impacts on WFD or Habitats Directive compliance
Potable water	Reduced flows; reduced water table,
Fisheries commercial or recreational	Phosphate emissions; artificial obstructions and impoundment of water, escapes of farmed species
Recreation boats	Fuel/oil leakage; waste dumping; damage to aquatic ecosystems; weirs and locks.
Commercial transportation	Weirs and locks; fuel/oil leakage; waste; damage to aquatic ecosystems
Hydropower	Artificial obstructions and channels (dams, weirs, leats) flow reduction; habitat damage/loss
Industrial use	Water temperature changes; pollution.
Irrigation	Reduced flow; increased nutrient emissions; ecological damage
Conservation of biodiversity	
Agriculture	Increased phosphate and nitrate emissions, chemical residues form pesticides; habitat damage
Septic tank run-off	Increased phosphate and nitrate emissions at diffuse points; habitat damage
Sewage outflows	Point pollution from phosphates and nitrates; EDCs; habitat damage
Direct disposal of waste	Pollution; habitat damage

The selection of sub-catchments for further investigation is premised on two factors. First, sub-catchments embrace knowable communities of place, where different actors are more or less aware of the impacts of their actions on water quality. Second, within these communities of place it is possible to manage a process of stakeholder engagement, which explores past and present actions compromising or enhancing water quality.

2 Criteria for sub-catchment selection

In this section we explore the differences in the selected sub-catchments in relation to three main dimensions: the physical and geomorphological status; the biological and chemical status; and the influence of anthropogenic demands on water. These are considered in turn below using the latitudinal classification indicated above.

2.1 Physical – Geographical – Morphological

2.1.1 The 60° catchments

The river Dee in North East Scotland rises in the Cairngorms National Park and enters the North Sea in Aberdeen. We have selected three sub-catchments for further consideration.

- The river Gairn is a fast-flowing, high-quality water body rising in the Cairngorm Mountains and joining the upper Dee near Ballater. It comprises a wide, shallow stream flowing over a highly glacially modified landscape. Its morphology is largely unaltered. The underlying bedrock is largely granitic in character.

- The Tarland Burn[1] represents a typical subcatchment of the middle reaches of the Dee. The stream rises in an undulating upland landscape of rounded hills and flows through farmland where the water-course has been modified to reduce flooding and enhance land drainage. The surrounding geology is varied, with significant morainic deposits and peat accumulation on surrounding hills.

- The Leuchar burn is a tributary of the lower Dee rising in modest hills and flowing through relatively intensively farmed land before joining the Dee near Aberdeen. The extensive low lying glacial landscape of deposition creates areas where water flow is often impeded. Loch of Skene is a shallow natural loch, which has been significantly extended by raising the exit point. Upstream of the loch, the watercourse is often canalised and there are further examples of obstructions largely to produce water power to run historic mills.

The Vansjø Hobøl (Morsa) catchment in Norway includes several large lakes and many smaller water bodies and is located on marine clays and coarser morainic material in southern Norway on the eastern shore of the Oslofjord. It is a lowland catchment. Lake Vansjø is dammed by a major end moraine on the southern edge of the catchment and therefore has a characteristic form with many bays and islands.

- Western Vansjø is the western basin of Lake Vansjø, and comprises many small creeks draining from mainly marine clays into a large, lowland and shallow lake. At the outlet there is a dam that regulates the water level, and a significant river exits from the lake.

[1] A burn is a stream or small river in Scottish dialect

- The Hobølelva subcatchment comprises the main river in the Morsa catchment with a variety of conditions along its course. Its velocity varies from slow meandering reaches to waterfalls and lakes. It drains from farmland and forests. There are two damaged mill sites where there were artificial obstructions.

- Skuterud is a creek in a catchment adjoining Morsa (River Hobølelva). It flows through farmland on underlying morainic and clay soils, and discharges into an artificially constructed drainage pond.

The River Yläneenjoki is in South West Finland is a heavily investigated catchment and includes areas with farming forestry and settlements. The main water course and many smaller streams flow into a lake, Lake Pyhäjärvi through a highly glacially disturbed landscape and drainage system. All the sub-catchments reported on below drain through Lake Pyhäjärvi. There are substantial differences in the proportion of silt and clay and bare rock in the different sub-catchments. All sub-catchments contain areas of morainic material and sand and gravel. There are low dams on the catchment at three places. Artificial wetlands have been constructed in all of the sub-catchments.

- The Peräsuonoja sub-catchment has a relatively high proportion of organic soils (at around 25% of the land area) and the area includes extensive mires but at the same time nearly 50% of the land area is covered by silts and clays, making it suitable for agricultural cropping.

- The Latvajoki sub-catchment in the upstream area has a very high proportion of the area under clay-silt soils (67%) making it the most agriculturally intensive sub-catchment in the Yläneenjoki basin.

- Mid-Yläneenjoki sub-catchment is located in the middle section still has a high proportion of the land surface covered by silt-clay soils (just under 50%) but also contains almost a third of the area under bare rock and thin soils.

- The Vanhakartano area sub-catchment is located in the lower section of River Yläneenjoki and is characterised by a high proportion of the land covered by bare rock and thin soils and (c 35%) and about one third covered by clay and silt soils.

2.1.2 The 50° catchments

Three sub-catchments are identified in the upper part of the Vltava, which we consider as that part of the Vltava draining into the Orlik reservoir. The Vltava rises in the Sumava mountains near the southern boundary of the Czech Republic. The bedrock of all three selected sub-catchments is composed mainly of intrusive volcanic and metamorphic rocks, including granite, orthogneiss, paragneiss, and granodiorite and, in the Lomnice and Skalice sub-catchments only, a small proportion of shale. All catchments have a range of geomorphological conditions from flat valley floors to steeper mountain slopes. In all cases the sub-catchments are heavily modified by major dams of recent origin and in the Lomnice and Skalice sub-catchments also by many fishponds that have existed in many cases for hundreds of years.

- The Lipno reservoir catchment is the highest of the three in a mountain region with significant forest cover. A dam was constructed in 1959 to provide hydropower. Resulting in severe flow reductions (i.e., by c.85%) downstream due to diversion of water via the Lipno power station over a c. 20-km reach of the Vltava River.

- The Lomnice sub-catchment lies mostly in an upland, agriculturally used landscape where the meandering river floodplain has been heavily altered by the construction of many shallow artificial lakes used for fish rearing.

- The Skalice sub-catchment also lies in an upland, agriculturally used landscape and has far fewer fishponds than the neighbouring Lomnice sub-catchment.

The River Thames is the largest river in southern England, rising in the Cotswold Hills in the South west of the UK and flowing eastwards into the North Sea at London.

- The River Thame sub-catchment flows into the river Thames south of Oxford from the east from the vales and low limestone ridges to the north of the Chiltern Hills. It is characterised by undulating agricultural lowlands where the harder beds of Cretaceous and Jurassic rocks form hills up to about 350 metres and the river finds a path through softer clays. The whole area is significantly affected by glacial deposition, with much land covered by boulder clay. The area includes a number of artificially constructed water bodies, some ornamental and others based on extraction of minerals.

- The River Lambourn sub-catchment is almost exclusively underlain by Cretaceous chalk and is a typical chalk stream, in that it is high quality, and in its upper reaches flows only seasonally. There are several places where water mills have dammed the river with low weirs to create a water head for power.

2.1.3 The 40°catchment

The River Louros flows into the Adriatic Sea and is located in South West Greece. The catchment, which is mostly underlain by limestone, falls naturally into three sub-catchments with rather different geological and geomorphological characteristics.

- The upper Louros catchment extends as far as the hydro-electric dam on the River Louros. It is dominated by permeable limestone that creates a dense sub-surface karstic hydrological network. It comprises upland and mountain landscapes.

- The Arta plain has karstic features in the upper part of the catchment but also contains extensive tertiary deposits which create fertile ground on the gentler slopes

- The Preveza plain also has karstic features in the upper part of the sub-catchment and deep fertile soils in the plain and, in addition, contains a lake, Lake Ziros.

2.2 Chemical and biological characteristics indicating presence of pollution

2.2.1 The 60° catchments

The Dee is one of the least polluted major rivers in Scotland, although some of the sub-catchments are characterised by compromised water quality.

- The River Gairn sub-catchment is a very unpolluted upland tributary of the Dee. It is confronted by one significant 'pollution' issue - the removal of trees from the upper catchment (including riparian trees) and the inhibition of reforestation by deer and sheep means that the headwaters, which are widely used for salmonid spawning, are in danger of warming and this risk is likely to increase with climate change.

- The Tarland Burn sub-catchment is characterised by significant diffuse pollution pressures (including Faecal Indicator Organisms (FOI), Nitrogen, and Phosphorus). There are also high levels of silt runoff, which not only transmits phosphorus into the water course but also causes extensive damage to salmonid spawning grounds. Septic tanks also contribute to the pollution load of the sub-catchment.

- The Leuchar burn is the most intensively farmed land on the Dee and this sub-catchment has relatively poor water quality because of faecal organic pollution, phosphate and nitrate run-off. Significant algal blooms occur on Loch of Skene, which comprises the lowest point on the investigated sub-catchment. Septic tanks also contribute to the pollution load of the sub-catchment.

The Morsa catchment has been investigated extensively over many years by several institutes, including NIVA (lakes) and Bioforsk (rivers and creeks).

- Western Vansjø sub-catchment is confronted by significant water quality problems caused by runoff from agricultural activity on the silt-clay soils and from residential sources. The principal nutrients are phosphates and nitrates. In the lakes the presence of these nutrients leads to the presence of algal blooms. Problems were particularly bad after a major flood in 2000, when additional sewage was washed into the lake. There are no known problems from heavy metal pollution.

- The Hobølelva sub-catchment is again characterised by extensive diffuse pollution from farming and scattered dwellings. Sources of nutrients include agriculture but also sewage from scattered dwellings andsmaller settlements. Analyses of e-coli show that values are high both in the tributary River Kråkstadelva and in the main monitoring station in River Hobøl (the station at Kure).

- As a highly agricultural sub-catchment, with intensive arable production, the Skuterud sub-catchment (which is not part of the Morsa catchment but adjacent to it) is affected significantly by agricultural run-off and possibly also sewage from scattered dwellings.

The River Yläneenjoki has been intensively studied by SYKE and numerous interventions have been undertaken to reduce the pollution burden. The overall pollution burden is significantly shaped by the percentage of land under different uses, with agricultural activity creating the major pollution problem through diffuse pollution. The pollution burden per unit area of land in a given use varies only slightly. However, the overall pollution burden is a function of runoff as well as applied plant nutrients and manorial deposition and varies significantly from year to year.

- In the Peräsuonoja sub-catchment about three quarters of the phosphate pollution and two thirds of the nitrogen pollution emanate from agriculture. However, the total pollution in kgs per unit area for this sub-catchment is only about half the average for the catchment as a whole.

- The Latvajoki sub-catchment is the most agriculturally intensive sub-catchment and this is the high level of diffuse pollution, which is about two times higher than the loading in Vanhakartano catchment.

- Mid-Yläneenjoki sub-catchment's pollution burden is also strongly shaped by agriculture. In general, the diffuse pollution emissions from non-agricultural land use are about 60% of those from farming per unit area.

- The Vanhakartano area sub-catchment is characterised by a higher proportion of diffuse pollution arising from non-farm sources, including forestry and residential land use. This area has the highest population density.

2.2.2 The 50° catchments

The different parts of the upper Vlatava basin experience very different water pollution challenges.

- The upstream part of the Lipno sub-catchment belongs to relatively pristine parts of the Vltava catchment. In the Lipno Reservoir, total P inputs in 2007-2009 arose mainly (i.e., 84%) from natural and diffuse sources (forest, grassland, pastures with beef cattle breeding). These sources contributed little to the eutrophication of the reservoir as they delivered P in low concentrations (<0.04 mg/l). In contrast, municipal wastewater contributed 16% of the total annual P input into the reservoir only but via one or two orders of magnitude larger concentrations (0.5-5.0 mg/l), which stimulated the growth of cyanobacterial blooms, especially during the warm and low-flow summer period. In the Lipno sub-catchment the nitrate pollution was low and its concentrations only slightly exceeded the natural background.

- In the Lomnice and Skalice sub-catchments pollution with nutrients is high. The pollution in the Lomnice sub-catchment in 2007-2009 originated mainly from municipal wastewaters and fish farms while the export from agricultural sources was much less important. Over 50% of phosphorus load was from municipal sources and 28% from fish farms. The farm sector was the major source of nitrate pollution generating 58% of the total.

- With respect to phosphorus pollution, the Skalice sub-catchment pollution burden derives mainly from municipal sources with 55 % of the total and agriculture generating only 22% of the phosphate. However, agriculture generated 72% of the nitrate pollution.

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The River Thames is both densely populated and intensively farmed.

- The River Thame is, by Thames standards, a relatively polluted sub-catchment with high levels of diffuse pollution from nitrates and phosphates from agricultural sources and additional point discharges from sewage works. There are additional problems of pollution incidents from the urban hub of Aylesbury and one source of Tributyltin compounds causing a current failure in the Kingsey Brook within the Thame sub-catchment.

- The River Lambourn has relatively few pollution problems. However, pollution still arises from three main sources: point sources such as sewage treatment works discharging effluent directly to the river and farmyard slurry tanks near the river that discharge to the river only when the groundwater intersects the surface to produce overland or near overland flow; 'point-diffuse' sources, including effluent from septic tanks and sewage which enter the unsaturated zone near the river; and diffuse sources including agricultural and other inputs away from the river (e.g. NO_3 and suspended sediments).

2.2.3 The 40°catchment

The different sub-catchments of the Louros have different pollution characteristics. Most pollution arises from diffuse and point-diffuse sources. There are no significant concentrations of other chemical pollutants (e.g. heavy metals or organic compounds) in the catchment as a whole.

- The upper Louros sub-catchment is largely pollution free because of the very sparse resident population and very limited economic activity.

- In the Arta plain sub-catchment pollution arises from agricultural sources, especially hog, poultry and crop production and from villages with limited capacity to treat sewage. Urban sewage works are also associated with some emissions.

- In the Preveza sub-catchment there are high pollution levels arising from relatively intensive agriculture and from human settlements. In the estuaries of the Louros river in this sub-catchment pollution from nutrients and high conductivity are present. A high concentration of nutrients (especially from agricultural activity) is present in the Amvrakikos gulf affecting fisheries, while biological indicators indicate a moderate to low pollution. The Amvrakikos gulf is an important natura 2000 site.

2.3 Water use and economic activities

In this section we describe the economic activity and water use in the area, only considering the specificities of sub-catchments where these are markedly different from the overall catchment.

2.3.1 The 60° catchments

The River Dee is one of the most important salmon rivers in Scotland and is widely used for recreational fishing. It occupies a major part in the scenic identity of North East Scotland in an area marketed as 'Royal Deeside' and has a substantial tourism industry in its upper reaches. The economy of the upper Dee is now largely tourism-based but highly influenced by the land use base with the greatest concentrations of tourism in hill and upland villages. The economy of the area in the middle reaches of the river is more dominated by productive land uses including agriculture and forestry, but those areas within commuting distance of Aberdeen are highly influenced by proximity to this major urban centre at the mouth of the Dee. The Dee is used for supplying Aberdeen with potable water.

As a headwater sub-catchment, the River Gairn sub-catchment is dominated by sport shooting including grouse moor and deer forest. The river is an important spawning ground for salmonids. In the lower reaches extensive farming is practised. Population density is very low. The local economy of the Tarland Burn sub-catchment is a combination of a land-based activity including farming, forestry and sporting and residential and tourism services associated with residential commuting to Aberdeen. The principal use of the water is for watering stock and providing spawning grounds for salmon. Many isolated properties use private water supplies from shallow springs and water courses also receive septic tank and sewage works outputs. The Leuchar burn is a mixed land use lowland catchment. The visual landscape is shaped by agriculture, but the economy is influenced by commuting to Aberdeen and by amenity residential development. Many isolated properties use private water supplies from shallow springs and water courses also receive septic tank and sewage works outputs.

The Vansjø Hobøl (Morsa) catchment in Norway contains about 40.000 inhabitants in the entire catchment area. The main townships are Moss that is located on the shores of the Oslo Fjord where the drainage basin exits into the sea; and Ski in the upper parts of the catchment (within the Hobølelva sub-catchment). The other settlements are mainly scattered farms, houses and cottages. Parts of the catchment are used for recreational purposes, including fishing, swimming, boating and trekking. The water supplies for the urban centre of Moss and the surrounding area come from the eastern part of Lake Vansjø. A hydro-power plant exists at the dammed exit from the catchment into the Oslo Fjord. The paper factory makes extensive use of the water, also at the dam. Water is also used for irrigation during the summer months.

Agriculture is the main income source in the outlying parts of the catchment of Western Vansjø, whereas several other income sources exist in the downstream parts near Moss, where industry and services are concentrated and where the paper mill is the single biggest employer. The Hobølelva sub-catchment comprises mixed land use with some areas where relatively intensive cereal production is practiced. Farming is the main livelihood in the area. The township of Ski is located in the upper reaches. Otherwise, the settlements are relatively scattered, often with private sewage solutions for wastewater treatment.

Skuterud is an outlier catchment which has been included in the study due to its good data The catchment and the agricultural activities in it have been extensively studied since 1990. In addition to reliable and continuous data on phosphorus and nitrogen-concentrations and water discharge in the stream, also data on farmer's activities have been recorded in detail. The main income in the catchment is agriculture, except from settlements at the headwaters where commuters live.

The sub-catchments investigated in the River Yläneenjoki basin in Finland all represent lightly populated rural regions with only a few hundred people at most. The rural economy is significantly shaped by agriculture and forestry and it is the different extent of agricultural land use cover and activity which is the principal contributing factor to water quality. The isolated dwellings in the area have septic tanks, which feed into the water system.

2.3.2 The 50°catchments

The different sub-catchments of the Vltava have different water pressures and demands. There are major differences between the upland sub-catchment and the other two adjacent more lowland sub-catchments.

The Lipno reservoir sub-catchment is used both for potable water and hydro-power production. The main uses of the water in the Lomnice and Skalice sub-catchments is for water supply to fishponds. The waters also take discharges form septic tanks and municipal sewage works.The River Thames is an important catchment for water collection and use for potable water largely through groundwater use and is a highly important leisure resource used widely for recreational boating and fishing. It receives sewage discharges from its very significant population. It also provides water for irrigation purposes.

The River Thame sub-catchment has limited recreational value but is a major recipient of sewage outflow from the large town of Aylesbury and a number of other towns and villages along its length. There is modest extraction of water for agricultural irrigation.

The River Lambourn sub-catchment is a relatively high quality water body important for conservation and fishing. It is highly important for collection in groundwater of relatively high quality water.

2.3.3 The 40°catchment

The River Louros is located in a zone of relative water scarcity and the demands placed on the water course reflect this scarcity. The upper Louros sub-catchment is relatively lightly populated but the impounded water body behind the dam is important in both hydropower and potable water supply. The area is dependent on primary industry, food processing and tourism but has generally low rates of economic activity and an ageing population. In the two more lowland sub-catchments (Arta and Preveza) the highest abstraction rates are observed for agriculture followed by of abstraction directly from the river for municipal use. These areas are more intensive agriculturally, with livestock being more prevalent in one sub-catchment (Arta) and cropping in Preveza. The two lowland sub-catchments contain extensive engineering works for irrigation purposes.

The Arta sub-catchment experiences multiple demands on the water body. There is significant extraction for municipal /domestic use. There are significant but not enumerated demands for irrigation and there are demands for a range of types of fish farm. Over and above these demands, the river is also used for outflows from municipal sewage works, septic tanks and other untreated wastewater.

The Preveza sub-catchment experiences high demands on its water for irrigation and human consumption, though demand for irrigation water is less than in the Arta area. This region has a less livestock-intensive agriculture than the Arta sub-catchment with the consequent impacts on water quality. The agricultural use of the catchment leads to nutrient enrichment from agricultural fertilizers and sewage disposal and pollution from inappropriate application of pesticides and inadequate waste management. The water body also takes discharges form municipal sewage works. There are some fish farms in the sub-catchment.

3 Discussion

The principal purpose of this paper is to indicate the rationale behind sub-catchment choice. The initial selection of catchments for investigation was based partly on the fact that there were known data sources associated with these catchments and that they represented the diversity of conditions found in different parts of Europe. The sub-catchments selected represent a very diverse range of conditions in different parts of Europe with respect to the demands on water and pollution of water and expose the within-catchment differences that will create constraining and enabling opportunities with respect to mitigation measures.

The data available to inform choices of the sub-catchments varies very considerably. In some cases there is only official data to draw on and that gives insufficient information with regard to some of the economically significant functions and ecosystem services provided by water. In other cases, especially the Norwegian and Finnish cases, there has been a great deal of scientific investigation already, which has provided a wealth of data.

Whereas the widespread nature of agricultural activity means that agricultural impacts on water quality through emissions of fertilizers, manures and pesticides over much of Europe are almost universal (given that we are ignoring pristine natural semi-natural environments as they do not compromise the requirements of the WFD and Habitats Directive), the impacts are nonetheless strongly shaped by intensity of agricultural practice, cropping regime and soil type. However other uses, such as commercial fishponds can also create very significant compromising conditions for water bodies in some sub-catchments.

In Table 2 we endeavour to summarise the diversity of conditions encountered within our case study sub-catchments with respect to the functions and economic demands satisfied by water resources.

Table 2 Economic Uses and Functions of Water using Ecosystem Services Approach

	Pot water	Fishing/ fish farming	Rec boats	Comm transp	Hydro	Ind	Irrig	Nature Cons	Ag waste	Septic dis	Sewage dis	Direct waste
Dee												
Gairn	*	**						***		*		
Tarland	*	**					*	**	**	**	*	
Leuchar			*		*		*	**	**	**	*	
Morsa												
West Vansjø		**	**		***	***	*	**	***	**	*	
Hobølelva	**	**	*				*	*	***	*	*	
Skuterud							*		***	*		
Ylanyoki												
Vanha Kartano								*	**	*		
Mid Ylanyoki								*	**	*		
Perasuanoja								*	***	*		
Latvajoki								*	***	*		
Vlatava												
Lipno	***	*	**		***			*			**	
Skalice		**					**				**	
Lomnice		***					**				**	
Thames												
Thame		*				*	**		***		**	
Lambourn	**	**					*	***	**	*	*	
Louros												
Upper Louros	***				**	**		**				
Arta		*				**	**	**	***	**	**	
Prevesa		*				**	**	**	***	**	**	

Key:

Blank = of no value

* = low value good/service/function

** = medium value good/service/ function

*** = High value good/service/ function

Legend: Pot: potable water; rec boating recreational Boating; Comm transp: commercial transportation; hydro: hydro-electricity production; industry: industrial demand for water; Irrig: agricultural irrigation; Nature cons: Nature Conservation; Ag waste: all agricultural-derived water pollutants; Septic dis: septic tank discharge; Sewage dis: sewage discharge.

4 Conclusions

It si evident from Map1 that we have achieved good spatial coverage across Europe in our case studies. It is evident from Table 2 that the conditions in the sub-catchments are sufficiently varied to afford interesting opportunities for comparison, but also that there are sufficient common problems, particularly those arising from agricultural pollution that enable interesting comparative analysis of different responses to phosphorus and nitrogen pollution.

These sub-catchments are the entities in which local stakeholders will be consulted and local mitigation measures will be assessed with respect to their cost-effectiveness.

5 Appendices

Appendix 1 Authors of the country reports on sub-catchments:

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