SEVENTH FRAMEWORK PROGRAMME

THEME 6: Environment (including Climate Change)

REFRESH

Adaptive strategies to Mitigate the Impacts of Climate Change on European Freshwater Ecosystems

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PU	Public	X
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Abstract

The EU Water Framework Directive and other plans and policies have advocated many measures to be undertaken, to help protect and improve the quality and quantity of European waters. However, these measures are sometimes not implemented on the ground. Why do some 'implementers' decide to undertake measures, and others do not? What barriers prevent universal adoption of water management measures? It is important to understand this, as in the future pressures on water environments may worsen due to predicted environmental changes. Future measures cannot be advocated without a better understanding of responses to existing measures.

This document presents a conceptual model of issues, or capacities whose presence or absence can act as barriers to adopting measures. This model is based firstly on a review of some relevant literature on pro-environmental behaviours, and based secondly on discussion about perceived barriers, in meetings with those supposed to implement measures in two contrasting European catchments (Louros in Greece and Dee in Scotland). The detail of the workshops and their findings are contained in REFRESH deliverables 1.14 and 1.15. By scoping local thinking about the applicability of measures future environmental changes, we also explored if the model holds for explaining future uptake and barriers to behaviour. The issues discussed in this work are relevant to shape the measures considered in the cost-effectiveness work of WP6.

The structure of the final conceptual model reflects nine broad capacities. One of the most important issues, unsurprisingly, is finances: nearly all measures require resources, and any individual or enterprise must have sufficient accessible capital to support this. Many of the issues are interlinked in various ways. Prices, markets and incentives are part of the external context that affect capital but also affect other decisions that can influence the environment (for example, planting of different crops can alter pressures on surrounding watercourses). Conversely, the sub-issue of the administrative and legal context can acts against the adoption of measures, when the setting is perceived as either weak (e.g. an absence of monitoring and auditing systems) or prohibitively complex .The next two issues are time and labour, which are closely related: one provides the other. When it comes to considering situation of the actor, not only business characteristics but also environmental characteristics and setting can also shape whether a measure is considered feasible and adopted. Social networks can influence adoption, for example observing or learning about an action undertaken by a trusted neighbour can influence likelihood of an individual deciding to carry out the same measure. Social networks help to provide learning experiences, which links to the requirement of skills and experience: knowledge is required not just of how to carry out practical actions but also the legal and bureaucratic context. The sub-issue of personal interest (in helping the environment) is likely to underlie an individual deciding to gain skills to allow them to adopt measures

Conceptual model of stakeholder views of measures and potential barriers to uptake

REFRESH

Adaptive Strategies to Mitigate the Impacts of Climate Change on European Freshwater Ecosystems

http://www.refresh.ucl.ac.uk/

Deliverable 1.13

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Summary

The EU Water Framework Directive and other plans and policies have advocated many measures to be undertaken, to help protect and improve the quality and quantity of European waters. However, these measures are sometimes not implemented on the ground. Why do some 'implementers' decide to undertake measures, and others do not? What barriers prevent universal adoption of water management measures? It is important to understand this, as in the future pressures on water environments may worsen due to predicted environmental changes. Future measures cannot be advocated without a better understanding of responses to existing measures.

There are multiple ways of describing or predicting behaviours, but many approaches seem only distantly related to understanding actual decisions over water-protection. Any approach to understanding behaviour must be broad and flexible enough to encompass all these groups. For example, in Scotland the key 'implementers' of water measures are private land-owners, whilst in Greece changing the behaviour of public bodies is more of a key issue. A previous research project (Dwyer et al., 2007) into pro-environmental behaviour change by UK farmers identified 7 types of capital which enabled farmers to adopt new pro-environmental behaviours: without these, farmers were likely to lack capacity to change. This has been modified according to the focus of the study (all types of implementers, not just farmers, and focused the water environment), and we have aimed for a model applicable cross-culturally.

This document presents a conceptual model of issues, or capacities whose presence or absence can act as barriers to adopting measures. This model is based firstly on a review of some relevant literature on pro-environmental behaviours. It is based secondly on discussion about perceived barriers, in meetings with those supposed to implement measures in two contrasting European catchments (Louros in Greece and Dee in Scotland). The detail of the workshops and their findings are contained in REFRESH deliverables 1.14 and 1.15. By scoping local thinking about the applicability of measures future environmental changes, we also explored if the model holds for explaining future uptake and barriers to behaviour. The issues discussed in this work are relevant to shape the measures considered in the cost-effectiveness work of WP6.

The structure of the final conceptual model reflects eight broad capacities, with two additional sub-issues. One of the most important issues, unsurprisingly, is finances: nearly all measures require resources, and any individual or enterprise must have sufficient accessible capital to support this. Many of the issues are interlinked in various ways. Prices, markets and incentives are part of the external context that affect capital but also affect other decisions that can influence the environment (for example, planting of different crops can alter pressures on surrounding watercourses). The next two issues are time and labour, which are closely related: one provides the other. When it comes to considering situation of the actor, not only business characteristics but also environmental characteristics and setting can also shape whether a measure is considered feasible and adopted. Social networks can influence adoption, for example observing or learning about an action undertaken by a trusted neighbour can influence likelihood of an individual deciding to carry out the same measure. Social networks help to provide learning experiences, which links to the requirement of skills and experience: knowledge is required not just of how to carry out practical actions but also the legal and bureaucratic context. The sub-issue of personal interest (in helping the environment) is likely to underlie an individual deciding to gain skills to allow them to adopt measures. Conversely, the issue of institutional context can acts against the adoption of measures, when the setting is perceived as either weak (e.g. an absence of monitoring and auditing systems) or prohibitively complex, so hard to understand and engage with.

The structure of this document follows that of our research. Firstly we describe the water environment, pressures and measures for the two catchments featured in this study. Then we review the literature relevant to understanding behaviours affecting the environment. On the basis of this a conceptual model is proposed. Then, the discussions of the workshops in the Dee and Louros catchments are summarised (the detail of these workshops is in REFRESH deliverables 1.14 and 1.15). Finally, these discussions are used to update and revise the conceptual model.

Contents

Glossary and acronyms

AES	Agri-Environmental Scheme
BD	EU Birds Directive
CAP	Common Agricultural Policy. A policy designed to support the agricultural sector within Europe. CAP provides a basic income to farmers, but since 2000 a second pillar has established a rural development policy (RDP).
CAR	Controlled Activities Regulations, regulations to protect the water environment in Scotland
CBD	Convention on Biological Diversity
DCMP	Dee Catchment Management Plan
EU	European Union
GAEC	Good Agricultural and Environmental Conditions. Must be complied with to receive payments under SRDP
GBR	General Binding Rules, in Scotland a set of rules that provide a statutory baseline of good practice, whose implementation will help to improve water quality.
GES	Good Ecological Status (under WFD, the aim for all water bodies)
HD	EU Habitats Directive
Implementer	An 'implementer' is someone whose actions directly affect the state of the water environment (either is quality or quantity) within a catchment. These actors decide whether to implement 'measures' for the water environment. They include, for example, farmers, other land-managers, local municipalities or water companies that may have responsibility for abstracting water for human consumption. The category of implementers does not include all stakeholders who have an interest in the waters (e.g. tourists who benefit from seeing a nice river), or actors who try to influence decisions (e.g. NGOs) or set the policy agenda and options (e.g. policy-makers).
LMC	Land Management Contracts, Scotland. Now closed to new applicants, the LMCs offered a range of pro-environmental management options, from which farmers could choose according to their individual requirements. It has been supplanted by a Land Management Options scheme.
LFA(SS)	Less Favoured Area (Support Scheme). A RDP scheme for supplementary support to farming where production conditions are difficult. Currently under review.
Measures	The actions required to meet the objectives of the WFD. Adopting a measure is a form of pro-environmental behaviour. The objectives may be reached through (1) command-and-control approaches, (2) financial incentives (3) voluntary initiatives.
NSRF	The NSRF (National Strategic Reference Framework) 2007–2013 constitutes the reference document for the programming of European Union Funds at national level for the 2007–2013 periods. It is part of the framework of the new strategic approach to the Cohesion Policy of the European Union to ensure that the assistance from the Funds is consistent with the Community strategic guidelines.

Pressures	Reasons for not achieving good status in a catchment. Pressures are tackled by adopting measures.
Ramsar	The Convention on Wetlands of International Importance
RBMP	River Basin Management Plan (with subsidiary Area Management Plans in Scotland)
RDP	Rural Development Plan (part of CAP), supporting agriculture as a provider of public goods in its environmental and rural functions, and rural areas in their development.
RSS	Rural Stewardship Scheme, part of pre-2010 SRDP in Scotland
SAC	Special Area of Conservation, designated under the HD
SEPA	Scottish Environment Protection Agency
SFP	Single Farm Payment, support for farmers as part of the CAP
SMR	Statutory Management Rules, rules for environmental protection in Greece, equivalent to GBR in Scotland (see above).
SRDP	Scotland Rural Development Programme. The Scottish version of the RDP, aiming to increase competitiveness in agriculture and forestry, improve the environment and the countryside and enhance the quality of life in rural areas.
SPA	Species Protection Area, designated under the BD
TOEB	Local Organizations for Land Reclamation – Topikoi Organismoi Eggeion Veltioseon. In Greece, these are legal entities that are compulsorily created following the establishment of major land reclamation projects and are overseen by the Ministry of Rural Development and Food (Basic legal framework Law 1218/1972). TOEB have responsibility for maintaining and extending all land reclamation projects in their area including irrigation, drainage and roads.
WFD	EU Water Framework Directive. Lays out guidelines with which EU states must adhere to in order to bring all water bodies under their jurisdiction up to certain standards.

Introduction: the problem of managing for freshwater quality and quantity

Promoting good ecological health of European freshwaters is challenging, even without taking into account interrelated future changes in land-use, pollution, climate and demands for water-supply. Multiple actions ('measures') need to be taken in order to restore freshwater ecosystems to good ecological health and sustain priority species as required by EU directives. These measures will need to be designed either to adapt to future environmental changes, or to mitigate their effects. This is the problem which the REFRESH project aims to tackle, to develop understanding of suitable adaptation, mitigation and restoration measures.

Current human activities contribute to five types of pressure on water systems, affecting both quality and quantity: diffuse source pollution, point source pollution, morphological changes, abstraction/impoundment of water, and invasive species. Within any one catchment, typically many sectors or social groups can contribute to these problems (for example, sports fisheries may unintentionally spread invasives; whilst manufacturing industry may be a source of point-source pollution). Tackling these various problems obviously entails changing many activities, and there are as many potential measures as potential pressures. For example, tackling diffuse pollution can be tackled by increasing information, regulating polluting activities, and/or offering financial incentives for measures to prevent pollution entering the watercourses. As such improving the water environment is a concern not only for specific sectors but across society.

To date various legislative approaches have been attempted to regulate and change activities that affect freshwaters. Whilst individual national states have taken a variety of approaches to managing freshwater, at a trans-national level, the freshwater environment is also the subject of the EU Water Framework Directive (WFD), the EU Habitats Directive (HD), the RAMSAR convention, the Convention on Biological Diversity (CBD). In particular, for most EU member countries, the ambitious WFD (2000/60/EC) is now the driver of efforts for improving the water environment (Kaika & Page, 2003). Although its implementation is country-specific, it mandates work at a river basin scale, setting statutory objectives (to reach GES and prevent deterioration), and set timelines for achieving these objectives.

The approach to water management in Europe has changed over time. It is possible to generalise perceptions of water as evolving; firstly from a resource providing potable water and rubbish disposal that was 'taken for granted', through to a system with multiple social and environmental values but vulnerable to multiple pressures and so in need of comprehensive management. In the historical past, water management was primarily concerned with safeguarding provision of potable water and immediate removal of human

What is the Water Framework Directive (WFD)?

The WFD is one of the most influential and demanding pieces of EU legislation for the environment. It seeks to:

–Prevent deterioration in the water environment

–Protect and enhance aquatic habitats

–Promote sustainable water use

–Reduce pollution of surface waters and groundwater

–Mitigate the effects of floods and droughts

The overall aim is to secure 'good ecological status' (GES) for all water bodies, measured in relation to biological and chemical quality, water quantity and the physical structure of water bodies.

From 2009, there will be three rounds of planning and action, with reviews in 2015, 2021 and 2027. The WFD is implemented through management plans (RBMPs) prepared with stakeholder input for designated river basins of regional scale. There are many bodies charged with implementing RBMP, including not only statutory agencies but also voluntary and private sector actors

wastes in surface waters, leading to technocratic solutions to deliver these services, and later a focus on regulating polluting industries (e.g. for the UK, Royal Commission on Environmental Pollution, 1992). Over time however, there has been recognition of the interconnection between multiple aspects of the water environment, and a growing concern for the need to protect all aspects of the water environment, not least to protect the various roles it provides for human populations (Newson, 1992).

The early focus on reducing 'end of pipe' emissions and using regulation has now shifted to more integrated approaches involving multiple actors and employing various approaches to encouraging pro-environmental behaviour that protects the water environment. There are currently a range of approaches to managing the water environment, designed to involve not only statutory agencies but also voluntary and private actors. Not only are certain activities restricted or prohibited (legal instruments) but there are also economic rewards (i.e. optional financial incentives for specific behaviours), and voluntary collective actions. This is all accompanied by a general culture of information provision and awareness-raising, although these efforts still need refinement to ensure messages are understood and processed as intended (Blackstock et al., In press).

Although many measures are now advocated to improve the water environment, it has become clear that problems persist. For example, at the time of writing, the Environment Agency in England has been criticised for spending millions of pounds yet failing to produce any significant change in land-management behaviours to avoid water pollution (National Audit Office, 2010). This part of the REFRESH project focuses on this problem. Why are measures to protect the water environment sometimes not adopted?

Methodology and Objectives

This study is designed to understand existing barriers to implementation of measures designed to achieve the objectives set out under the WFD and HD. It focuses on decision-making (by 'implementers') within the catchment: which measures are being implemented, and why certain measures are not. This information will contribute to understanding how stakeholders can adapt to future environmental change. We do not examine other important issues, such as the technical efficacy of those measures, but this is considered in other parts of the REFRESH project.

Therefore, our objectives are:

1. Review i) the pressures on the two catchments in Greece and the Louros, ii) the measures are required to achieve the objectives for WFD/HD, and iii) identify who is intended to adopt the measures (the 'implementers').
2. Review the literature and propose a conceptual model useful for understanding implementer behaviour.
3. Probe which measures are being implemented and which are not, and the reasons why, using workshops in each catchment.
4. Revise the conceptual model and examine its use in understanding barriers to implementation.

This document addresses objectives 1 and 2: it reviews the water environment and pressures in each catchment, and then goes on to propose a conceptual model that may be useful for understanding why measures are (and are not) adopted. The information about the catchments also reflects on objective 3. Objective 3 will be explored in workshops in the two catchments, and objective 4 will be addressed by an exploration of the data collected in the workshop.

Test sites for the conceptual model

Scotland and Greece are both EU member states charged with implementing the WFD and HD, but they have few other similarities. The northern temperate Dee catchment and the Mediterranean Louros catchment are biogeographically and climatically different. Their pre-WFD legislative and cultural contexts differ, along with the land-uses. Residential settlements occur in both places, along with agriculture, although both these land-uses take markedly different forms. As a result of climate and land-use choices, water quantity is a somewhat more pressing issue in Greece, whereas water quality issues, particularly diffuse pollution, are an issue for both catchments. In future, neither area will escape climate change, although its effects will vary between the two. Scotland is forecast wetter springs and drier warmer autumns than at present (Blackstock et al., 2009).

The Dee Catchment, Scotland

The catchment of the river Dee is located in north east Scotland (Figure 1). Its characteristics are particularly well understood relative to other Scottish river catchments, because of the work of the Dee Catchment Partnership, which since 2003 has been working with stakeholders to restore good habitat and water quality. Much of the description presented here derives from its recent Dee Catchment Management Plan (DCMP) (Cooksley, 2007).

The majority of the catchment's human population lives in Aberdeen, a city of over 200,000 people, where it meets the North Sea on the east coast. Settlements in the catchment are small and are concentrated around the river and lowlands. On the lower-lying half of the catchment, from Aboyne to Aberdeen, the river is surrounded mainly by agricultural land and residential settlements at Aboyne and Banchory, as well as Aberdeen.

Figure 1 A general map of the Dee Catchment noting the main population centres. Produced by Nikki Baggaley. The shaded-green area represents the catchment. The shaded-brown area is the area of the Cairngorms National Park. Minor and major roads are pink and green lines, respectively.

The natural environment

The Dee River is considered the best example of a large natural highland river in Scotland, and it traverses a great altitudinal range. The source arises at 1220m on a semi-artic plateau in the Cairngorm Mountains (the 'highlands'). The river then flows eastwards through increasingly gentle terrain (the 'lowlands'), until reaching sea at the busy Aberdeen harbour. The average flow of the river is $43 m^3 s^{-1}$ with minimum flows in summer and the highest flows in March. There are few – but large – bodies of standing water (called Lochs).

The catchment's soils generally have low level of nutrients and limited buffering capacity against atmospheric or other pollutants, particularly in the upper catchment. Granite underlies much of the upland moorlands, with naturally high levels of iron in the soil and runoff. The overall climate is cool temperate and so the land in the upper catchment has generally been not affected by intensive land changes. Semi-natural land cover persists in the west and southern areas, ranging from montane and alpine heath, through to moorland and blanket bog. The area is also notable for containing a large amount of Scotland's remaining 'Caledonian' pine woods.

Activities in the Dee

The human uses of the Dee catchment differ markedly between the upper and lower catchment, along with soil, climate and topography.

Highland land uses include forestry, sheep farming, and sporting/game management.

Lowland land uses include forestry, intensive agriculture and mixed farming (sheep, beef and cereal), light industry and residential centres.

Fishing and tourism occur throughout the catchment.

Human activities and pressures

The uplands are generally unsuitable for agriculture, and are used only of extensive sheep farming and some forestry. However below the plateau there has been more forestry planting (both conifers and deciduous).

Although the productive capacity of the uplands is low, they have great aesthetic and recreational value, bringing in tourism and supporting the local economy. These areas are sparsely populated. The land is mainly divided between large estates. In Scotland, 'estates' are large rural land-holding, not necessarily dedicated to any particular land-use, historically arising from the extensive land-ownership of an elite. They are actively managed, often via a professional estate management firm ('factor'), usually for a combination of land-uses (normally involving sports (shooting), forestry, fisheries and hill-farming). Many water sports are based in the river and lochs, and the river also supports Scotland's most important salmon fishery.

Below Ballater the land is more suitable for intensive agriculture and other land-uses, so is more intensively managed. Arable crops are grown in an area of alluvial plains in the lower section of the catchment, past Banchory. Many of the farms are mixed, producing some combination of cereals, sheep and beef. (Centuries of agriculture in this area mean that many boulders that would otherwise occupy the riverbed instead now contribute to walling and dykes.) There is also some light industry, including a saw-mill at Banchory, and whisky distilleries.

Nearly all users of the river, or managers of its land (e.g. agriculture, light industry, forestry, estate managers, and fisheries) have the potential to adversely influence the quality or quantity of water in the Dee. Accordingly, the eastern part of the catchment as far as Banchory has been designated as a Nitrate Vulnerable Zone (NVZ). Furthermore, the Dee is generally relied on to provide drinking water for population centres (some of which are increasing) and to receive effluent discharges. Effluent can come from sewage treatment plants but also from poorly-maintained domestic septic tanks.

Legislation and policies relevant to the water environment

There are various designations relevant to the Dee's waters, but the WFD (2000/60/EC) is the main piece of legislation relevant to managing the water environment in Scotland (SEPA, 2002). It has been in force in Scotland since 2003, through the Water Environmental and Water Services (Scotland) Act 2003. The WFD, together with the Habitats Directive (92/43/EEC) acts as an umbrella for several other directives and laws. For example, waters used for the abstraction of drinking water are

designated as Protected Areas under the WFD. This includes the river Dee, as it supplies the whole of Aberdeen city and over half of Aberdeenshire. However, only Aberdeen beach, by the outlet of Dee, is designated as an official Bathing Water under the Bathing Water Directive (76/160/EEC). High nitrate levels are thought to be a significant challenge for water management, so under the WFD the Nitrates Directive establishes action programmes in Nitrate Vulnerable Zones.

The Dee contains several European 'Natura 2000 sites', which are recognised under article 6 of the WFD when they are wholly or partly water-dependent. These sites are the Special Areas of Conservation (SACs), designated under the Habitats Directive, and the Special Protected Areas (SPAs) designated under the Birds Directive (79/409/EEC). The Dee is particularly notable for containing three SAC-qualifying species (Atlantic salmon *Salmo salar*, the freshwater pearl mussel *Margaritifera margaritifera*, and the European otter *Lutra lutra*). The economically valuable Salmon are also protected under the EU Fisheries Directive (2006/44/EC). There are also three wetlands of international importance under the Ramsar Convention. It is Government policy that Ramsar or Natura 2000 sites are also notified under the national-level designation Site of Special Scientific Interest (SSSI), and so the majority of the Dee and its tributaries fall within 28 SSSIs, giving them some additional statutory protection. As well as containing five national nature reserves (NNRs), the upper catchment past Aboyne also falls with the Cairngorms National Park (CNP). The CNP is a national level designation quite separate from European directives. However it is relevant to the water environment because its Development Plan has statutory planning controls for the protection of natural beauty, wildlife and human heritage. All of these designations entail legislative responsibilities for environmental protection.

Under the WFD, each river basin must have a River Basin Management Plan (RBMP): these were delivered for Scotland last December (Scottish Government, 2009; Scottish Government & Environment Agency, 2009). Each plan sets out the current status of water bodies and the programme of measures to achieve the objectives, which should be 'good ecological status' unless alternative objectives are set. There is one strategic-level plan for the whole of Scotland, with more detailed regional plans. The Dee catchment falls within the North East region of the Scotland RBMP.

Dee environment and pressures

The management plans for north-east Scotland have just been finalised, and outline the main pressures, impacts and measures considered regionally relevant (North East Scotland Area Advisory Group, 2010). The Dee Catchment is better understood than most, because WFD work has been pre-dated by the work of Dee Catchment Partnership (DCP) since 2003. Figure 2 summarises the present condition of the Dee's 33 water bodies (all sections of the main river, its tributaries and lochs), as recorded by SEPA's database. It is clear that the Dee is far from a pristine system, and as most of the water bodies require action to improve their status.

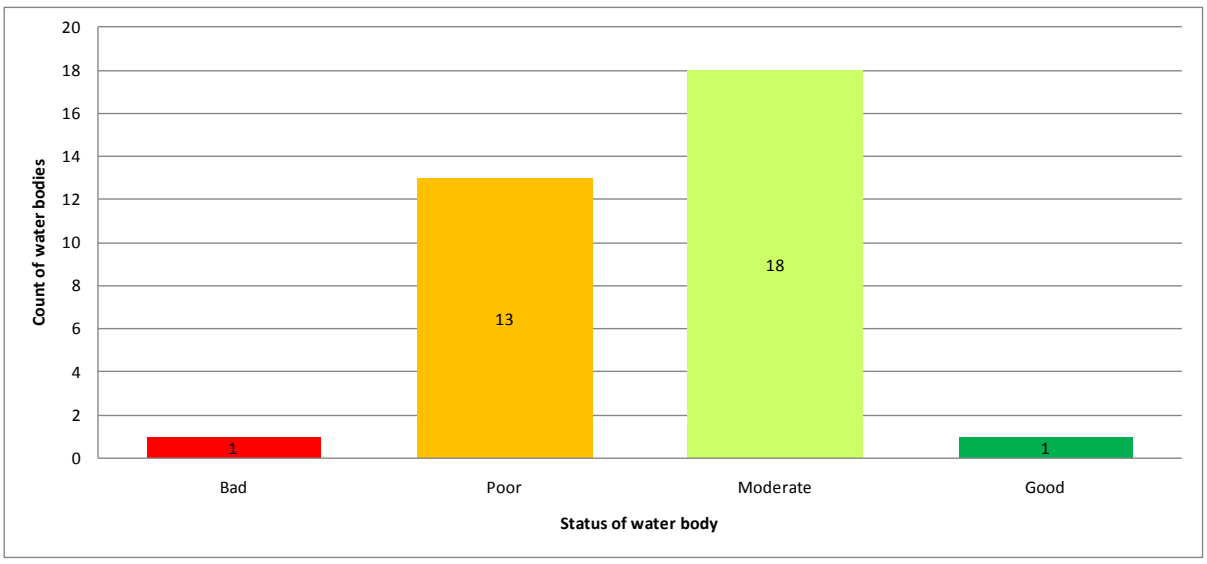

Figure 2 The current status of the 33 water bodies (rivers and lochs) in the Dee, from the 2010 SEPA database.

There are several pressures on the water environment. The North East Area management plan (North East Scotland Area Advisory Group, 2010) identifies three key problems: (1) Nutrient enrichment, predominantly from agricultural land use and sewage disposal; (2) Abstraction and impoundment, for drinking water supply, irrigation, hydropower generation and industries such as distilling; (3) Alterations to beds, banks and shores, such as barriers to fish passage, culverting, straightening and channelisation, due to agriculture, forestry, urban development and historical activities. Some of the historical activities which relate to morphology – such as straightening rivers – have persistent effects even though they are less often instigated than in the past. The area plan is complemented by the detailed analysis of the problems local to the Dee, in the DCMP (Cooksley, 2007). Table 1 presents the main pressures and the activities that contribute to them, as summarised from these documents.

Table 1 The broad categories of pressures and land-uses involved in the Dee (summarised from the DCMP and the draft North East Area Management Plan)

	Point Source Pollution	Diffuse Pollution	Abstraction & Impoundment	Invasives	Morphology
Principal land-uses					
Agriculture –livestock	X (e.g. sheep dip)	X (e.g. fertiliser run-off)			X (much historic)
Agriculture – arable		X (e.g. fertilisers)X	X (irrigation)		X (much historic)
Forestry		X			
Residential (septic tanks)		X			
Light industry (e.g. paper mill, distilling)	X		X		X
Hunting / moorland		X			X
Public agency					
Public sewage treatment and drainage	X				X
Drinking water			X		X
Energy generation			X		X
Land-fill	X?				
Flood control					X
Other water uses					
Fisheries				X	X
Recreation & tourism		X			

SEPA's pressures database indicates the relative importance of these pressures for the Dee. Although this database represents some of the most up-to-date source of information of the Dee, it is continually in the process of being updated. For example, no pressures from non-native invasive species are currently recorded in the database, but invasive pressures do exist: for example, floating *Ranunculus* spp. (water crowfoots) have been noted as causing problems for anglers (Cooksley, 2007). However, the database still has use for pointing out the relative importance of different types of pressure. From this data (summarised in Figure 3) it is clear that the two key pressures are diffuse pollution and morphology. Forestry and farming activities are most likely to be contributing to these problems. Water supply and sewage disposal are particularly problematic for the other pressures of abstraction, flow regulation and point source pollution.

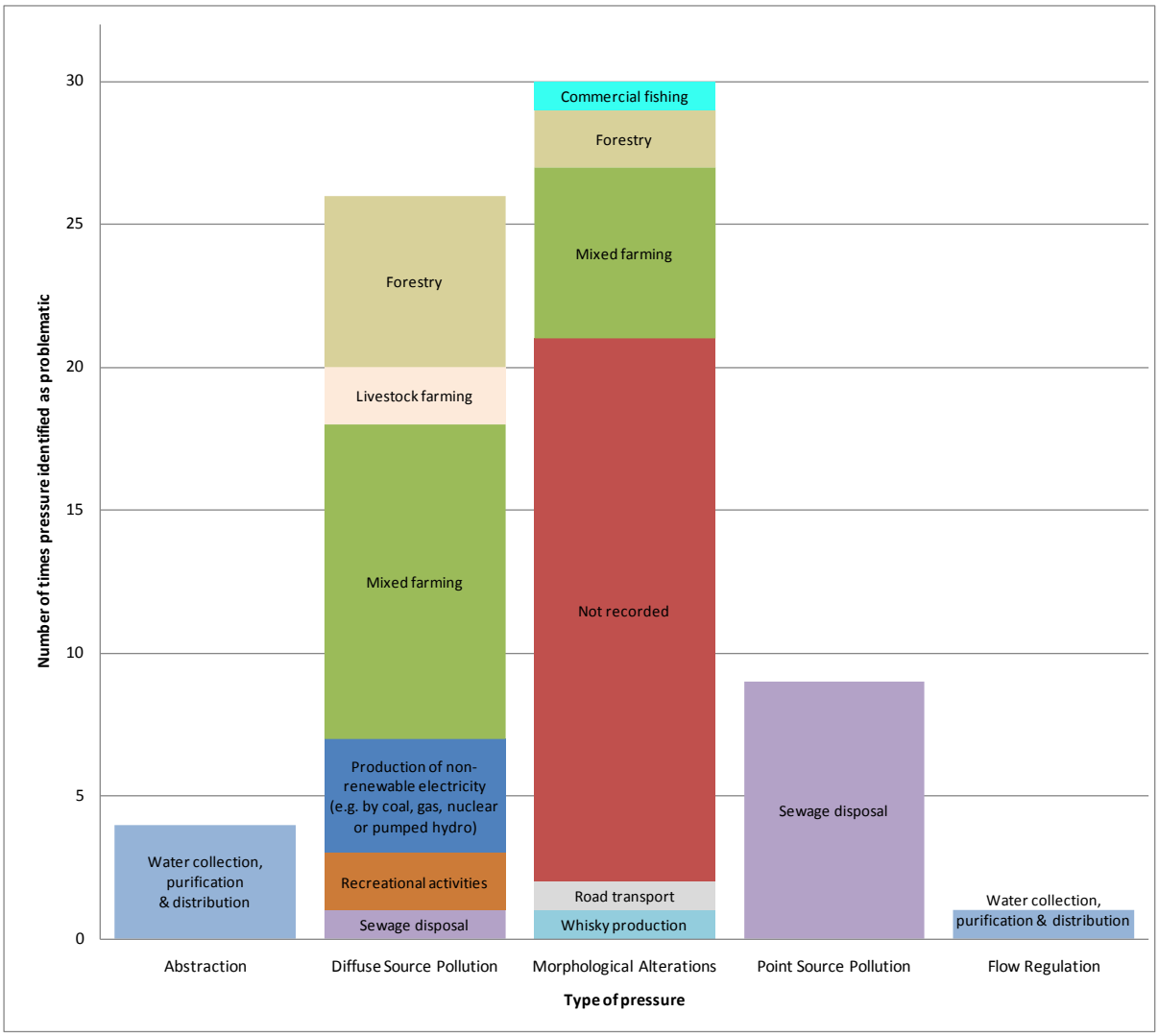

Figure 3 The pressures on Dee water bodies, and the contributing activities, as recorded in SEPA's pressures database on July 2010. One water body requires no action as it is already in good condition. For the other 32 water bodies, multiple pressure-types may be identified, and/or multiple activities for a particular pressure (e.g. for one water body, both forestry and farming may contribute to a diffuse pollution pressure). For this reason, the total number of pressures identified here is greater than the total number of water bodies.

Tackling pressures in the Dee: who to engage

From Figure 3 it is already possible to guess at who contributes to some of the pressures: for example, water purification and distribution is almost exclusively the business of the public utility 'Scottish Water'. However, not all of the key groups can be inferred, particularly for morphological pressures, where little detail has been recorded in the source database. By contrast, Figure 4 more clearly shows the extent to which different groups contribute to the ongoing pressures in the Dee, as recorded in the same SEPA database. From these two graphs, it is clear tackling the two key pressures (diffuse pollution and morphology) will require significant action and engagement from farmers and landowners, as well as other groups, particularly public agencies involved in forestry, administration and water supply. Those contributing to pressures are generally those expected to adopt and implement measures (the 'implementers').

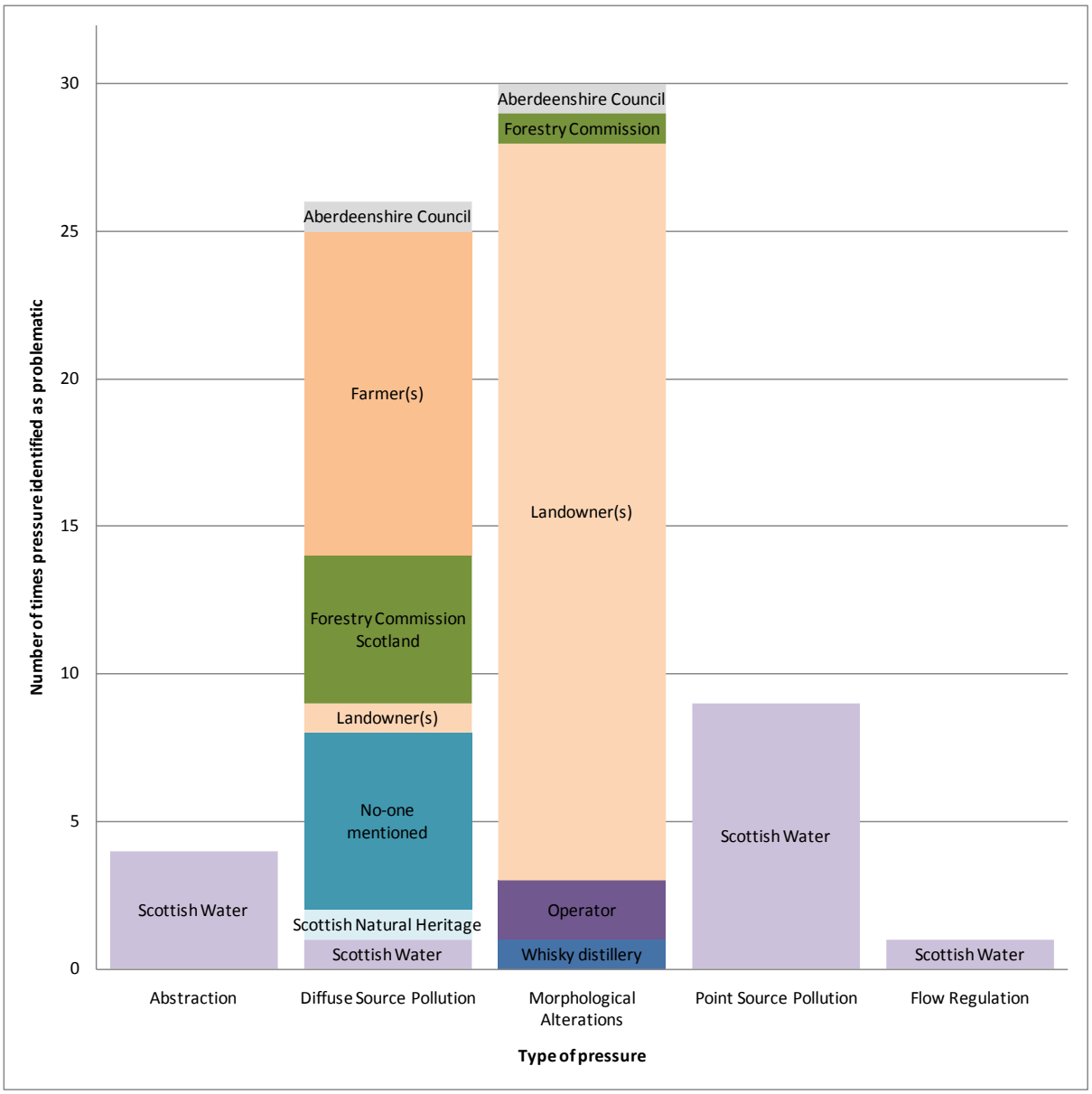

Figure 4 The actors responsible for the different pressures on the Dee water environment, as recorded in SEPA's pressures database on July 2010.

Tackling pressures in the Dee: existing and future measures

In the UK, regulating and licensing sources of pollution has historically been the dominant approach for controlling activities affecting water, particularly pollution emissions. Since 2005 most sources of water-borne pollution have been regulated by SEPA under the Controlled Activities Regulations (CAR). Discharges, disposal to land, abstractions, impoundments and engineering works are all regulated through CAR, with activity subject to permission and/or payment of fees. However tackling pollution, particularly diffuse pollution (from multiple minor contributions) is recognised as particularly problematic by SEPA and the DCP, with agriculture and urban runoff some of the main sources (Langan et al., 1997). Experience suggests that issuing licences or permits can be quite effective at tackling point source pollution (for example, that emitted by industry or a sewage works' discharge) but is not so effective with diffuse pollution (Macleod et al., 2007).

Because of the problems of 'pure' regulatory approaches, there are now links with other UK schemes and policies, to increase uptake of measures. Many of these schemes are aimed at the farming sector. The most basic level of compliance is linked to the farming subsidies provided by the Common Agricultural Policy (CAP), delivered under a Rural Development Programme (RDP). The basic

single farm payment (SFP) cannot be received without complying with the Good Agricultural and Environmental Conditions (GAEC) or achieving cross compliance with the relevant legislation (including WFD and HD). In addition to these requirements, there are several optional agri-environmental schemes (AES) which can provide extra money in exchange for pro-environmental actions. Several of these actions can benefit water bodies (e.g. more efficient use of fertilisers and manures, creating buffer strips, controlling rainwater run-off, correct storage and use of chemicals and responsible waste disposal). The four major types of environmental subsidy schemes that have been available in the Dee are shown in Table 2 (though the situation in 2010 is under review). Sutherland (2010) suggests that most farmers in upper Deeside actively consider these as part of their decision rationale, when making investments, although they may be less pertinent to non-commercially oriented hobby farmers. Understanding business models and financial constraints of farmers is clearly relevant, though all these subsidy schemes do nothing to incentivise the adoption of measures by non-farmers. However uncertainty – whether in these schemes or in other influences – is thought a universal a deterrent against adopting new behaviours (Miller et al., 2009).

Table 2 Four major subsidies to farmers in the Dee catchment, adapted from Sutherland (2010).

	Environmental subsidy	**Accessible to?**	**Guaranteed if rules met?**	**Provisos**
Single Farm Payment (SFP)	No	Farmers historically receiving at least one of 8 production subsidies	Yes	Good agricultural and environmental conditions— cross-compliance
Land management contracts (LMC) now Land Management Options	Yes	Those eligible for SFP	Yes	Standard of good farming practice
Rural stewardship scheme (RSS). Now closed to new applicants. Rural Priorities is current similar scheme.	Yes	Anyone with an agricultural business license	No	Standard of good farming practice; specified general environmental conditions
Less favoured areas support scheme (LFASS) (under review)	Acreage-based; minimum headage standards	Farm at least 3 ha of eligible forage land in the Scottish less favoured areas (LFAs) and maintain a grazing herd	Yes	Good farming practice guidelines and environmental conditions, equivalent to those underpinning the RSS scheme.

In additional to agricultural sources of diffuse pollution, there are several other significant sources of diffuse pollution. These include land-use for forestry (via acidification, siltation, and nutrient enrichment), and waste waters from households (septic tank) together with the pluvial runoff associated with the hard surfaces residential areas. There has been some progress in tackling these problems. The Forestry Commission has prepared guidelines on Forests and Water but these have yet to be universally implemented. Urban areas are now subject to the application of 'Sustainable Drainage Systems' (SuDS) via the development planning regime. However, tackling some of the problems that arise from existing private land-uses remains challenging:

Plans made under the WFD emphasise the need to adopt a variety of approaches to tackling water pressures. Several types of measures that are outlined in the northeast area plan of the RBMP reflect the key pressures and contributors identified earlier. (North East Scotland Area Advisory Group, 2010). An extract discussing priority measures is presented in Table 3. The measures planned reflect the key pressures and contributing activities identified earlier (e.g. in Figure 4). The first priority is to work with private land-owners to tackle the issue of diffuse pollution. The second priority it to work with water utilities to reduce point source pollution, followed by initiatives to remove and modify the diverse causes of barriers to fish migration.

Table 3 Key measures to achieve the priorities for North East Scotland, as identified in the North East Scotland Area Management Plan (North East Scotland Area Advisory Group, 2010).

1)	**To reduce the number of water bodies affected by nutrient enrichment from rural land use.**
	Focused work to address rural diffuse pollution using voluntary, economic and regulatory measures will start in 2010. This work is steered by a national partnership, and includes a campaign to promote the uptake of the diffuse pollution General Binding Rules, coupled with a targeted catchment approach where SEPA staff will work directly with land managers in priority catchments. In the north east of Scotland, the Buchan coastal, Dee, Deveron and Ugie will be 'priority' catchments between 2010 and 2015. More information is available at www.sepa.org.uk/water/river_basin_planning/dp_priority_catchments.aspx
	Partnership work on guidance and environmental improvement, including action by Scottish Natural Heritage and others to improve the condition of designated nature conservation sites, and action by Forestry Commission Scotland to ensure that best practice is used when felling, replanting and managing forestry. In addition, local authority guidance and policy on topics such as sustainable urban drainage systems, soakaways and buffer strips will reduce the impacts of nutrient enrichment on water bodies.
2)	**To reduce the number of water bodies affected by sewage discharges and other point source pollution.**
	Investment in sewerage infrastructure. Scottish Water's planned programme of investment measures has been developed in partnership with SEPA and others, in order to address pressures on water bodies. In the north east of Scotland, this programme will deliver specified improvements in sewerage provision, sewage treatment and water supply. SEPA and Scottish Water will also work closely with local planning authorities to ensure that the impacts of future developments are considered in an integrated way.
	Ongoing regulation of discharges. SEPA regulates and works closely with licensed operators to reduce the impacts of discharges. In the north east of Scotland, this will involve licensing and partnership work with distilleries and energy providers.
3)	**To reduce the number of water bodies affected by changes to beds and banks, and barriers to migratory fish movement.**
	Information gathering and measures planning. The above work in diffuse pollution priority catchments will identify impacts and plan mitigation measures for changes to beds, banks and shores in the Buchan coastal, Dee, Deveron and Ugie catchments.
	Economic incentives and regulation to remove fish barriers. SEPA's restoration fund can contribute towards the removal of fish barriers from watercourses, while regulation can be used to ensure that the impacts of barriers are mitigated through the use of good design and fish passes. In the north east of Scotland, the River Dee Trust and Deveron, Bogie and Isla Rivers Trust have used restoration funding to remove a number of fish barriers, and it is hoped that work to prioritise and remove or mitigate barriers will continue through the actions of area advisory group stakeholders.
	Ongoing work by Fisheries Trusts, Boards, local authorities and landowners to remove fish barriers, improve bank conditions and improve spawning habitats for migratory fish.
4)	**To reduce the number of water bodies affected by abstraction.**
	Investment. Scottish Water will aim to minimise the amount of water required for supplying customers, through efficient management of the water supply system.
	Planning. SEPA and Scottish Water will work with local planning authorities to highlight areas where abstraction for drinking water is putting pressure on water bodies, and where future development must be constrained or the development impacts mitigated.
	Regulation. SEPA will work in partnership with hydropower generation companies and other operators who abstract water (such as whisky producers) to review licenses under the Controlled Activities Regulations (CAR).

The Dee Catchment Management Plan (DCMP), ahead of the RBMP process, provides additional information on the current priorities for measures in the Dee. The package of voluntary initiatives contained with the DCMP demonstrates the shift away from a focus on regulatory approaches. The DCMP is particularly focused on encouraging measures for the restoration of urban watercourses, reducing pollution from septic tanks, reducing diffuse source pollution, and floodplain restoration. The DCMP focuses on using an integrated catchment management to achieve GES. (The production of DCMP, in itself, can also be regarded as a useful measure for the water environment.)

Within particular sub-catchments there has already been work to tackle the problems that prevent good water quality. The '3-Dee Vision project' worked with local communities in Tarland, Elrick Burns, and Loch Davan, notably introducing demonstration sites for WFD measures to tackle rural

and urban diffuse pollution and flooding. In addition, an EU-funded 'LIFE-Nature' project focused on improving habitat for salmon, which included work with farmers to reduce riparian grazing and install silt traps, to prevent further degradation of in-stream habitat (SNH, 2008). These projects provide an additional insight into what problems are considered locally important.

There are clear patterns in the types of measures advocated in the DCMP, the north-east area plan of the Scotland RBMP, and in individual catchment projects. In particular, working with private land-owners has been a key focus for tackling problems of diffuse pollution and changes to water body morphology. These are not the only groups contributing to pressures (in particular, many remedial measures will require the involvement of the utility Scottish Water). However, experience to date suggests that encouraging private land-owners to adopt measures for the water environment is particularly challenging.

Therefore, we intend to focus on working with private land-owners and, the pressures of diffuse pollution and morphology, when discussing barriers to WFD implementation in the Dee. We will also consider meeting with Scottish Water and some other public agencies who locally make decisions affecting water use within the Dee.

The Louros Catchment, Greece

The Louros catchment is located in the region of Epirus (Ipeiros NUTS 2 – GR21). Epirus is defined as water district GR05 for the purposes of the Water Framework Directive and the Louros catchment is defined as river district GR13. Figure 5 shows the location of the catchment. The Louros water catchment is situated in the central south part of the Epirus water district and is extended to 926 Km^2 and to three of the four prefectures of Epirus, namely the prefectures of Preveza, Ioannina and Arta. Louros catchment is adjacent to Acherontas river district (GR12) on the north and the Arachthos river district (GR14) on east and north. The water bodies in the Louros catchment affect the towns of Preveza, Filipiada and Lefkada and directly affect the irrigation in the plains of Preveza and Arta. Louros is important as it contributes with its delta and estuaries to one of the most important Natura 2000 sites in Greece, the Amvrakikos Gulf. Under the Water Framework Directive Louros has not as yet a management plan but only some, rather dated, studies. These include the study by the Institute of Geology and Mineral Exploration on the aquifers of Epirus (Nikolaou, 2001), the Specific Environmental Study of Amvrakikos (the then Ministry of Environment, 1997) and the Pilot Study for the Management of Water Resources of the Water District of Epirus (Ministry of Industry, 1993).

The natural environment

The total length of the river is 72 km. The river's first springs are in the Tomaros Mountain near to the place of ancient Dodoni, the oldest reported ancient Greek oracle. Major rivers contributing to Louros are Xiropotamos of Thesprotiko and Skala (average allotment of 2.8 m^3/sec) and Vosa (average allotment of 3.7-4.0 m^3/sec). Vosa collects the water from the Hanopoulo springs. These springs are of a chlorine-sodium (NaCl) and hydrosulphur (H_2S) composition and a steady allotment of 3.7 m^3/sec and thus influence the quality and quantity of Louros River downstream. The quality of Louros water downstream is also influenced by Vathi spring which contributes sulfur oxide (SO_4). At the commune of St. Georgios (north of the town of Fillipiada), the Louros river accepts water from the springs of St. Georgios. These springs are situated 120m above sea and are used mainly for supplying through gravity municipal water that is used by the towns of Arta, Preveza, and the island of Lefkas that altogether account for almost 100,000 inhabitants. At St. Georgios location there is also the first hydroelectric power plant built by the Public Power Corporation S.A (DEH AE) in 1963 with a dam and an associated artificial lake.

Important water bodies in the area include the Zirou Lake that shares the same aquifers as the Louros River, and wetlands at the Amvrakikos Gulf that are formed by the estuaries and deltas of Louros and Arachthos rivers. The Amvrakikos Gulf is a designated Natura 2000 site (GR 2110001). The estuaries of Louros River contribute to the lagoons of Tsoukalio and Rodia and part of its drained waters contribute to the Loggarou lagoon.

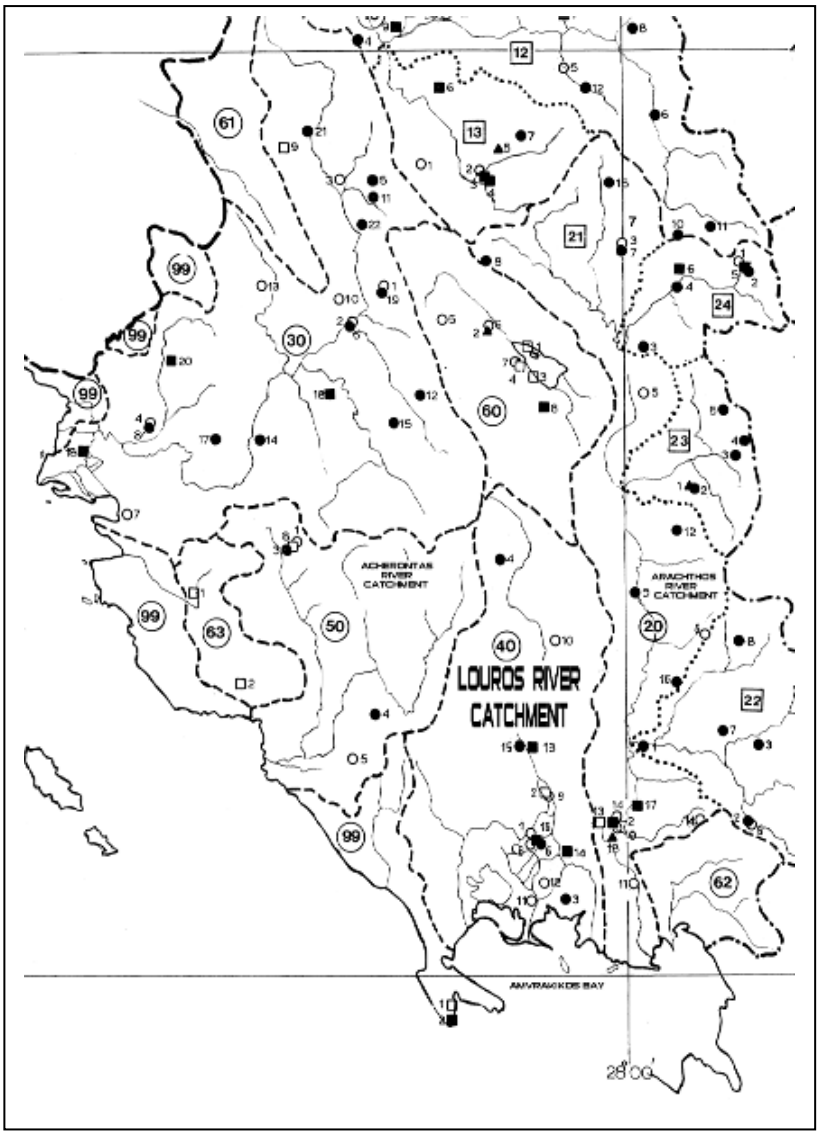

Figure 5 A general map of the Louros low catchment, with part of the adjacent Arachthos and Acherontas catchments.

Louros is a typical karstic watershed with numerous subsurface waters and a network of aquifers due to extensive limestone and flysch. The plains of Arta are alluvium formations due to sedimentation of clay and sand, that, in some places exceeds 150 m above limestone. The water balance of Louros is positive and in association with the adjacent water catchment of Arachthos, they can provide four times the water demanded by agriculture in the plains of Arta and Preveza as well as the water demanded for municipal use by the towns of Preveza, Fillipiada, Arta and the island of Lefkada. Louros allotment ranges from an average minimum of 9.6 m^3/sec in September to an average maximum of 18.1 m^3/sec in April. Louros drains to the north of the Amvrakikos gulf but its discharge does not really influence the water levels in the lagoon. Floods are rare (one important occurred in 1995) and do not contribute to the hydrographical formation of the area. What is important for the water balance of the lagoons is the operation of the drainage constructions that formulate a dry agricultural area just before the lagoons and the flood preventing embankments at the lagoons.

Human activities and pressures

The uplands are partly forested with fir, pines and oak as well as bushes and shrubs, which form the Mediterranean scrubland vegetation known as maquis, which consists of leathery, broad-leaved evergreen shrubs or small trees. There is no significant wood production in the uplands other than wood for charcoal. Despite the fact that the productive capacity is low and thus, the uplands are unsuitable for agriculture, there is space for small family used vegetable gardens or forage

cultivations. However, the uplands are used extensively for sheep and goat farming. The lowlands are the major plains of Preveza (irrigated exclusively by Louros) and of Arta (partly irrigated by Louros but mostly by Arachthos). The major cultivation are orange tree plantations covering more than 15% of the utilized agricultural area followed by olive trees for oil (and much less for edible olives) and fodder plants. Corn also takes some 10% of the area while vegetables including potatoes and tomatoes are less extensively cultivated. It is important to note that the area taken by plantations increased by almost 10% between 1981 and 1991 and remained relatively stable after that year. The area occupied by corn and vegetables has also increased following increases in the prices of these products. All cultivations in the area – especially the orange tree plantations and corn – are very demanding of irrigation water, and so farmers have demanded the expansion of the irrigation and associated drainage network: new infrastructure is now planned.

Farming in the area is of the typical Greek family farm model with relatively small land size (average of about 5 ha) and significant fragmentation in the uplands. Fragmentation has been reduced in the lowlands due to compulsory consolidation projects that follow the expansion of the irrigation network and the institution of Local Organizations of Land Reclamation (TOEB). As concerns animal raising, only the prefecture of Preveza has any important hog farming activity with 35 large units and 15 units of bovine raising. Poultry production is not as important in the Louros catchment as it is in the adjacent watershed of Arachthos with large units being located in the prefecture of Arta and especially in the commune of Kostakia that is bordering the Louros case study area.

Inland fishing in the case study area refers both to fishing in rivers, lakes and lagoons as well as with fish farming especially trout farming. The water of the Louros is used by two large trout farming units with a capacity of about 500 tn per year, and also by several smaller units, which occupy an average of 0.2 ha per unit. Studies by ETANAM, the development agency of the area, have shown that there are significant opportunities for expanding intensive and extensive fish farming. Especially the latter can expanded in the lagoons of the estuary of the Louros.

Manufacturing activity is really restricted to food processing with the most significant units being a meat processing and a tomato juice unit, one slaughter house and small olive oil extraction and refinery units and a low capacity cheese making unit. The tourism sector is not well developed within the geographic boundaries of the Louros water catchment and thus not significant. The only area that has been developed for tourism is the area of the commune of Nikopolis with a capacity of almost 500 beds.

Finally, water from the Louros River is used for the production of energy while water from Saint Georgios springs is used by the municipalities of Arta, Fillipiada, Preveza, the island of Lefkas and several smaller communes. It is important to note that in the uplands of Louros and due to impenetrable subsoil, there are no springs and several mountainous communes face severe water problems.

Legislation and policies relevant to water environment

The legislation and policies relevant to the water environment of the Louros catchment can be put into two broad categories. Firstly, those directly applicable to the Louros catchment and, secondly, legislative measures or policies that are applicable to the whole of Greece and are relevant for the Louros catchment as well.

From the first strand of policies one should recognize the potential of the Water Framework Directive (WFD – 2000/60/EC) and of the Natura 2000 legislation that should apply specific measures and management plans for the Louros catchment. These two policies have the potential to become the two most important legislative acts concerning with water management in the Louros catchment. Greece adopted the WFD under Law 3199/2003. Consequently, Joint Ministerial Decision 43504 (5/12/2005) defined categories of permits for water use and the execution of projects utilizing water while Presidential Decree 51 determined measures and processes for the integrated protection and management of waters in Compliance to Directive 2000/60. In Greece, the Louros catchment has been recognised as river district GR12 within the Epirus water region. However, the application of the

WFD in Greece has shown a considerable lag and, as a result, no managing authority is in place and yet, there is not any management plan. The Louros estuary is part of the Amvrakikos Natura 2000 site (GR2110001) and Louros directly discharges in the Tsopeli lagoon (north west Amvrakikos gulf) and affects the Tsoukalio and Rodia lagoons. Waters drained from Louros irrigated fields affect the Tsoukalio Lake, and Rodia lagoon and part of the Lagarou lagoon. Since 1990, the Joint Ministerial Decision (JMD) 30027/1193/9-3-1990 defined the protected areas of the Amvrakikos gulf for the country's compliance with the Ramsar convention and the EU's directive 79/409 for protection of birds (that was latter on modified by directive 81/845). Today, the Amvrakikos gulf has designated three zones according to Ramsar Convention an SPA zone according to directives 92/43 and 79/409 for the protection of birds, an archaeological site in the area of Nikopolis and other spots protected for cultural purposes. However, it is important to note that the Integrated Management Plan that was submitted by the Natura 2000 Management Authority has not been accepted because of considerable local opposition and reaction. Thus, the JMD laying down the detailed management plan for Amvrakikos has not been issued.

From the second strand of policies, the cross-compliance directive (EU Regulation 1782/2003) is the most important policy directly affecting the quality of water. In Greece, the first cross-compliance measures were introduced by Joint Ministerial Decision 324032 of 24th December 2004 adopting European Union Regulation 1782/2003. Cross-compliance is the creation of a link between the receipt of direct income support payments by a farmer and his/her compliance with certain rules which are in the interests of society as a whole. The rules set out farm practices for the protection of the environment, food safety, animal health, animal welfare, public health, plant health and environmental condition. If the rules are not respected, a reduction or cancellation of direct payments is possible. Among the many cross-compliance rules, Good Agricultural and Environmental Condition (GAEC) require farmers to respect certain minimum standards for maintaining their land in good agricultural and environmental condition. These requirements are defined by the Member States at national or regional level and include the protection of soil against erosion, the maintenance of soil organic matter and soil structure, and the avoidance of the deterioration of habitats for wildlife. The soil erosion standards require that on parcels with a slope of over 10 % a green cover is obligatory during the wet period, ploughing should follow the contour lines, be carried out on the level or diagonally, or that stable uncultivated strips should be created as containment zones, at distances in keeping with the characteristics of the land and the slope. On such parcels of land, irrigation may not take the form of flooding and terraces or natural borders should not be destroyed. The soil organic matter standards require that farmers must cultivate grain legumes and incorporate them into the soil, in addition to the main crop, on 20 % of the cultivated area of their farm each year so that in a period of 5 years all farmland has been rotated. Furthermore, and depending on the local conditions, farmers must choose to follow one or more of the following practices for the remaining area of their crops: First, incorporation into the soil, second grazing the stubble, or thirdly mulching the ground with the remains and incorporating them into the soil the following spring. The only soil structure standard requires that a farmer must not carry out mechanical field operations on waterlogged or frozen soils. Finally, under Minimum Level of Maintenance, farmers should comply with the minimum stocking density for pasture land, which was set at 0.2 livestock units per hectare for all categories of animals. Besides the GAECs, farmers should comply with Statutory Management Rules (SMRs) which, among others, addresses the Nitrates Directive (91/676/EC) and establishes the Nitrate Vulnerable Zones (NVZ), the Sewage Sludge Directive (86/278/EEC), the Groundwater Directive (80/68/EEC) and of course the Fauna, Flora and Habitat Directive (92/43/EEC).

Other important general legislation but relevant to the Louros catchment include the Environmental Impacts Assessment legislation (EIA) introduced by JMD 69269/5387/1990 that defines project and activities subject to EIA and includes major water abstraction and irrigation projects as well as major hydroelectric (power generation) projects. The JMD 18186/271/88 defines measures and restrictions for the protection of water environments and Law 1739/1987 for the protection and management of water resources, JMD 46399/1352/86 on water quality and Law 1634/1986 adopting the Barcelona Convention concerning with the protection of Mediterranean waters from pollution and other international or European obligations that have been undertaken from the CITES or the Bern conventions.

The Louros environment and pressures

Unfortunately there are no complete studies identifying the key problems and pressures of the water resources in the Louros catchment. Various fragmented studies, however, reveal that the major pressures concern with:

1) Nutrient enrichment from agricultural fertilizers (Kotti et al., 2005), manure leaching, sewage disposal and inappropriate waste management (Kotti et al., 2005) especially in the remote and small communes
2) Pollution from inappropriate application of pesticides (Albanis et al., 1995; Albanis & Hela, 1998; Konstantinou et al., 2006; Tsangaris et al., 2010) and inadequate waste management
3) Major alterations to the hydrological network in the plains due to extensive irrigation and drainage infrastructure

In general, there are not acute abstraction problems rising from unbalanced water supply and demand and the infrastructure is adequate for providing all major users with the demanded quantities of water. Table 4 presents the main pressures and the activities that contribute to them. However, future pressures on abstraction will exist if demand for municipal (including tourism) water increase and demand for irrigating new agricultural sites continue. As concerns abstraction for agricultural use, it is important to note that the Louros catchment irrigates areas that border the Arachthos catchment and especially in the plains of Arta, the boundaries of the two catchments diffuse into each other and are altered under the continuous effect of continued irrigation and drainage infrastructure. Thus, the cooperation of the two management authorities for the two catchments is crucial.

Tackling pressures in Louros: who to engage

We identify two groups of actors. Firstly, those termed “water users” and secondly those involved in the regulation and management. The users are individuals such as farmers, livestock producers, fish farmers or small scale food processing or other manufacturing owners, and fishermen. Users also include municipal authorities, large public utilities including power generation authorities and first or second tier cooperatives and special authorities for water supply to agriculture. Many of these water users’ actions generate pressures on the water bodies, usually pollution (Table 4). Municipal authorities also are included to potential polluters because they perform solid and liquid waste management and can affect the aquifers or the surface waters. All these groups who exert pressures on the water environment are likely to have to implement measures to improve the water environment.

The second large group contains all regulating, planning or monitoring authorities which act as gatekeepers for water use, influencing the first group. The prefectural and regional authorities of the Ministry of Food and Agriculture are a typical example of such a multi-faceted organization. Various Ministry authorities are obliged to plan water use for agriculture, manage and expand irrigation and drainage infrastructure while others are obliged to enforce cross-compliance and protect waters from agricultural pollution while representatives of the Ministry participate in the management authority of the Natura 2000 Amvrakikos site. This seems to create a contradiction within departments of the same authority and thus, one should engage representatives from all departments that directly manage, plan or monitor water resources. Furthermore it is important to engage development agencies that act as intermediate gatekeepers for activities related to water use (agriculture, fish farming, fishing, etc), such as ETANAM or the Natura 2000 management authority as well as the local authorities. All these organisations are important and influential, but they are not ‘implementers’, that is they do not directly act to exert pressures or adopt measures within the catchment.

Finally, the presence of NGOs is not strong in the area but representatives from centrally located NGOs is have an influential role because environmental NGOs appoint, by law, one member to the board of the management authority of the Natura 2000 Amvrakikos site.

Table 4 The broad categories of pressures and land-uses involved, in the Louros catchment

	Point Source Pollution	Diffuse Pollution	Abstraction & Impoundment	Invasives	Morphology
Principal land-uses					
Agriculture –livestock	X (e.g. hog farming)	X (Incidental waste discharge)	X		X (present)
Agriculture – arable		X (e.g. nitrate fertilisers and pesticides)	X (irrigation)		X (present)
Residential (septic tanks)		X			
Light industry (e.g. food processing industry)	X		X		X
Public agency					
Public sewage treatment and drainage	X				X
Drinking water			X		X
Energy generation			X		X
Land-fill	X				
Flood control					X
Other water users					
Fisheries		X		X	X
Recreation & tourism		X			

Tackling pressures in Louros: existing and future measures

The whole regulatory framework (previously described in the section on legislation, on page 18) defines restrictions and administrative procedures for water abstraction, utilization and disposal of used water and applies to the whole of the Louros catchment. In addition, there are several measures which provide economic incentives to both the agricultural sector and other sectors. The text below focuses on incentives available for farmers, but these are complemented by a set of subsidies provided to other economic activities such as subsidies for the manufacturing or tertiary sector that are available by the National Strategic Reference Framework (NSRF) 2007-2013.

Table 5 presents a summary of the main agricultural measures currently in operation at the Louros catchment. Besides cross compliance measures, several measures that directly or indirectly affect water resources include measures of the Rural Development Plan (RDP) for Greece 2007-2013. Measure 2.1.4 of the RDP defines the rules for the application of Nitrate Vulnerable Zones based on article 36 and 39 of Regulation 1698/2005, and article 27 of Regulation 1974/2006. The plains of Arta and Preveza were included as eligible areas with the JMD 50981/2808/11.12.2006. This area includes considerable area of the Louros catchment. Under this scheme it is estimated that 10,000 ha in the Arta-Preveza plains will be eligible for subsidies. Under this measure farmers are obliged to reduce water consumption by 25%, reduce fertilizer use by 30% and devote 5% of their land to wildlife by leaving it uncultivated. The South part of Amvrakikos is included in another measure of the RDP concerning with protection of water ecosystems.

The measure 2.13 supporting farming within Natura 2000 sites commands that harvesting should be performed from the centre of the field to its outer parts, preservation of natural flora in the boundaries of the fields and demands from farmers to allow for uncultivated islands within the field, does not allow the use of grazing animals on pasture from 1st of March to 31st of August so that uncultivated zones and the natural borders are not grazed and finally commands the protection of natural water collection elements. Finally, farmers should comply with all extra rules imposed by the Management Authorities of specific Natura 2000 sites.

Table 5 Major subsidies available to farmers in the Louros catchment

	Environmental subsidy	Accessible to	Guaranteed if rules met?	Provisos
Cross compliance	No	Obligatory scheme to all farmers receiving Single Farm Payments	Yes	Good Agricultural and Environmental Conditions— Statutory Management Rules
Rural Development Plan Measure 2.14 Protection of Nitrate Vulnerable Zones	Yes	Those eligible for SFP	No	According to Regulation 1698/2005
Rural Development Plan Measure 2.13 Support to farming within Natura 2000 areas	Yes	Those eligible for SFP	No	On top of cross compliance rules farmers undertake a series of farming practices aiming at protecting wild life, waters, and soil. Further obligations may be defined by the managing authorities of the Natura 2000 site.
Rural Development Plan Measures 211 and 212 Support to farmers in mountainous and Less favoured areas	Area based or per animal unit	According to Regulations 1698/2005 and 1974/2006	Yes	Good farming practice guidelines and environmental conditions, equivalent to those underpinning the cross compliance

Another important agri-environmental measure that has indirect effects to water quality protection is the support to organic farming under Regulation 2092/91 on Organic (Biological) agriculture that in Greece is adopted by Joint Ministerial Decision 245090/10-2-06. Organic agriculture supports farmers to avoid the use of certain chemical substances (fertilisers or pesticides) that contribute to soil nitrate and contamination from other residual substances and thus protects water quality from surface runoff contamination or contamination of aquifers from infiltration. Other agri-environmental measures also have indirect effects on the abstraction of irrigation water and its quality. Such measures include the extensification of agricultural production, set aside schemes, etc.

It is important to note that other agricultural measures included in the RDP can also work towards water conservation purposes and be coordinated with a water resources conservation policy. The Farm Modernization Scheme is a vivid example. The Farm Modernization scheme supported by Regulation 1698/2005 (articles 20 and 26) and Regulation 1974/2006 (article 17) is implemented within Axis 1 Measures of the Rural Development for Greece. The measure aims at supporting farms that will undertake investments for improving productivity, increasing incomes and supporting employment in rural areas. The measure is partly targeted as LFAs receive higher assistance than farms located in other parts of Greece. Furthermore, young farmers are also targeted with higher capital subsidy rates. This is very important because the majority of young farmers have undergone special training for the acquisition of the so called “Green Certificate” that introduces them, among others, to environmentally friendly and sound cultivation practices. The Farm Modernization Scheme can support “green” investments such as the replacement of older irrigation equipment (sprinklers, etc) with more environmentally wise equipment such as drip irrigation.

Understanding decisions to implement measures

There are a suite of stakeholders that can directly or indirectly influence the water environment. However, this project is focused on those individuals, organisations and public agencies (implementers) who directly undertake measures within the catchments. In this section the literature potentially relevant to understanding their behaviour is reviewed.

The integrated catchment management approach encouraged by the WFD involves many types of agencies, organisations and individuals. This is partly because diverse groups are contributing to existing problems with the water environment. As the descriptions of the Dee and Louros catchment demonstrate, many of the various pressures within a catchment result from the actions of most of those who live or work within it, not just large organisations and agencies. Pollution may arise, for example, from a farmer focused on fertilising his crops, or a public agency aiming to dispose of sewage safely. In this example, both of these actors would need to change their behaviour and adopt measures in order to comply with the WFD. Very different actions and incentives might be required to achieve this (these should be identified in the relevant RBMPs).

As many water bodies continue to experience problems, it is useful to know what is preventing the adoption of measures that have been recommended. This is why this project focuses on those who actually implement measures at the scale of a catchment – 'implementers' – rather than other stakeholders and interests that set policies and/or frameworks for implementation.

As all the potential implementers of measures are so diverse, the motivations, concerns and constraints on their behaviour are likely to be equally diverse. Understanding behaviour in this situation is challenging, and any conceptual model likely must be broad and flexible to accommodate all the various constraints of all types of implementer.

Influencing the behaviour of these individuals or organisations that have no public role or mandate is particularly challenging. For example, in Scotland, it has proved very challenging to change the polluting behaviour of numerous private land-owners, whose small contributions have a cumulative large impact on water bodies. Some of the literature discussed below therefore focuses on the extensive literature based around understanding land-manager behaviour. As land-managers are a rather diverse group, this literature could be useful for highlighting some of the motivations and constraints common to all types of actors, particularly private rather than public actors.

Literature on pro-environmental behaviours

Many studies of behaviour are based in psychological theories about how values and attitudes combine to influence actions. The Theory of Planned Behaviour (Ajzen, 1991) is particularly influential: enduring and broad values are thought to influence specific attitudes to behaviours, in combination with specific beliefs and perceived behavioural control (perception that an action is possible).

The psychological literature has been concerned to understand universal predictors of behaviour, rather than to influence behaviours in specific situations. Nevertheless, psychological theories have proved useful for understanding pro-environmental behaviours (e.g. Fielding et al., 2008) and in the context of land-management (usually agricultural studies) (Burton, 2004a). For example, a study Bedfordshire farmers found they were more likely to adopt hedge management practices if they held pro-conservation values and believed their actions would benefit wildlife (Beedell & Rehman, 1999). Individual personality traits such as openness and extraversion have also been found to influence attitudes towards adopting new practices (e.g. Willock et al., 1999), particularly attitudes to risk (e.g. Greiner, 2009). The broad idea of specific attitudes being informed by a variety of pieces of information and general values is used here as a broad underlying model for structuring how we think decisions are taking to adopt a new behaviour (i.e. implement a measure).

A prerequisite for changing behaviour is information and awareness. Levels of environmental awareness in Europe are sometimes argued to be high, and recently it has become a common component of agricultural extension efforts. For example, in at least one case it has been shown that

the barrier to farmers adopting pro-environmental measures was not a lack of environmental awareness, but social factors (Michel-Guillou, 2006). In the case study catchments, levels of awareness and support for pro-environmental action are not known and must be checked. Without it, pro-environmental measures are unlikely to be adopted. However, it is more likely that other factors hinder adoption of measures. For example, a cross—European study of farmers found farm size, type, tenure and timing all influenced AES adoption (Wilson & Hart, 2000).

Table 6 The key factors influencing farmer decision-making as identified by Edward-Jones et al (2006), based on quantitative methods seeking to integrate insights from economics, psychology and other social sciences.

1	socio-demographics of the farmer
2	psychological make up of the farmer
3	the characteristics of the farm household
4	structure of the farm business
5	the wider social milieu
6	characteristics of the innovation to be adopted

Perhaps the most obvious potential influence is financial factors, as most private actors survival depends on bringing in sufficient income to exceed expenditure, and even public organisations do not have unlimited budgets. This is reflected and supported by many economic studies of the business models (e.g. Amador et al., 1998). However, even these economic studies, supplanted by quantitative psychological research perspectives, increasingly note the influence of social context (e.g. Edwards-Jones, 2006). Decisions are not just about money.

Many studies focus on adoption of new innovations in business practices, but this may also be relevant to more specific issue of decisions to adopt pro-environmental measures. For example, Edward-Jones' review of the literature, for farmers, suggested six categories of issues that could influence decision-making to adopt new innovations and behaviours (listed in Table 6). Convincingly, studies grounded in data, imposing little expectations on key factors, come to similar conclusions about the types of influences on decisions. Some of these studies also propose how these influences combine: for example, Farmar-Bowers (2009) used decision-systems theory to suggest that personal interest influenced evaluation of an issue before external considerations (Figure 6). Our main concern here is *what* factors influence decision-making, rather than how they are internally processed, but this study does suggest the potential importance of intrinsic personal factors.

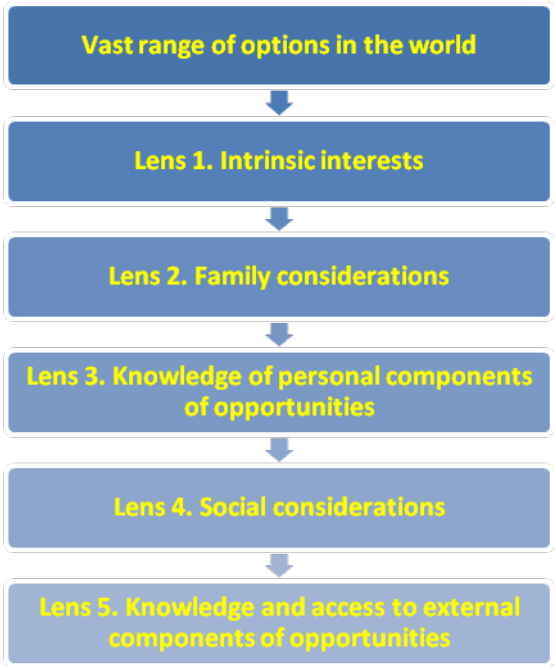

Figure 6 Farmar-Bowers (2009) idea of different cognitive lenses used by farmers to evaluate a new opportunity.

The influence of social context on decision-making has been picked up by psychological-style studies but is naturally the focus of sociology. This naturally starts from the position that decision-making does not take place in a social vacuum. As such, perceptions of what 'should' happen and how things 'should' be done are culturally defined and can not be well understood from a individualistic model of decision-making, or a focus on tangible economic concerns (Morris & Evans, 1999). Multiple institutional influences will also provide constraints and incentives on behaviours. So, rather than focusing on an individual as a business actor, sociological approaches point out the key role of culture in mediating technical or economic drivers of change (Dwyer et al., 2007). For example, persuading farmers to adopt reduced tillage practices can prove difficult because ploughing is often seen as part of European cultural backgrounds

(Lahmar, 2010; Tranter et al., 2007). In general, European farmers are thought to be highly production-oriented, not least because of production incentives historical subsidy structure of the CAP (Wilson, 2001), and they may be little symbolic value from taking part in agri-environmental schemes (AESs) (Burton et al., 2008) or agro-forestry planting (Lloyd et al., 1995; Mather, 1996).

This implies decision-making cannot be understood by considering only tangible constraints such as infrastructure and financial capital but must include their interaction with intangible socio-cultural factors. Some of these intangible influences are likely to be deep-seated and semi-unconscious (akin to Bourdieu's notion of 'habitus' as the cumulative product of socialisation and interaction) (Slee et al., 2006).

Although some influences may be common to a group (e.g. many farmers' orientation to productionism), culturally-defined meanings will naturally vary between places and over time, and be constructed specific to particular places and social groups (Murdoch & Pratt, 1993). Even within one area a diversity of practices may be observed (such as styles of farming Van der Ploeg, 1993), simply because a variation in cultural constructions (e.g. for pig farming Commandeur, 2003). It is therefore unwise to assume that any group perceived to have something in common (e.g. business practice) will feel identically about all issues and hold all values in common. However, it is true to say that perceptions of what others think of us (social norms) does always have some influence over decisions (Bamberg & Moser, 2007). For example, Burton (2004b) found English farmers practiced "hedgerow farming" by adapting their management decisions in response to their neighbours judgements about 'good' agricultural practices

Searching for key issues influencing behaviour of diverse groups

Theories about behaviour suggest that our decisions to undertake behaviour (e.g. implementing a WFD measure) are subject to many influences, both intangible socio-cultural influences and tangible economic factors. This implies that understanding a particular behaviour requires a detailed understanding of its context. Despite this, various authors have suggested it is possible to identify some of the key issues influencing behaviour, beyond the general prediction that both tangible and intangible factors matter.

Considerable attention has been given to identifying key issues influencing land-managers, particularly farmers. Land-managers are only a sub-set of the potential implementers of WFD measures. However, as they are a heterogeneous group, so any issues common to them may also be relevant to other groups. They are also directly relevant to the key implementers targeted in the Dee catchment. They are therefore briefly reviewed here.

Different authors' ideas about the key distinctions between farming have lead to various 'typologies' of farmers being proposed. Typologies which have focused on variations in basic farming business model have tended to emphasis certain details of (i) a farm's enterprise and (ii) a farmers' personality. Key features of the enterprise were how 'business-like' it was, its size, and the emphasis on specialising in a single activity, versus a diverse portfolio of activities. Key features of a farmer's personality were level of education, with higher education, together with an open character, being seen as linked to business strategy and willingness to risk investment in new activities. A typical typology is shown in Table 7, drawing on detail in Shucksmith & Hermann (2002) and Slee et al. (2003). Typologies which have focused on adopting new practices suggest this is more likely by diversified businesses, and these may also be more likely to adopt specific pro-environmental actions such as measures to protect the water environment. Conversely, farms built around single activities, with no outside income and possibly high-levels of debt are far more likely to be constrained in what they will even consider doing. Similarly, typologies focused on farmer adoption of AES (Lobley, 1998; Morris, 1995; Wilson & Hart, 2000) reiterate the need for new practices to fit with existing business models, but also suggest that although financial incentives will influence farmers to participate, where they bring profit and fits with existing activities, a personal interest in conservation is also important, particularly for one that enhances rather than maintaining the environment. Wilson and Hart also point out the influence of tenure: non-land owners were less likely to be involved in AES, perhaps because they were less likely to take a long-term perspective. Although there have been

no typologies specific to adoption of water measures, it seems likely that similar concerns and constraints could apply.

Table 7 A typical typology of farmers, particularly drawing on Shucksmith & Herman, 2002.

Farmer type	Characteristics
Hobby	- Small farms, no plans to expand - New to farming - Not dependent on farm income - Policy irrelevant/uninteresting
Pluriactive successors	- Small farms, many inherited - Many non-farm jobs, these of increasing importance - Policy felt as influential
Struggling monoactives	- Medium sized farms - Agricultural income moderate, often seen as a struggle - Usually farming background but little training - Adamant not to alter practices or diversify, low use of policies for modernisation
Contented monoactives	- Large farms, usually background in farming and also training - High debts but prosperous - Focused on farming and its continuation - Influenced by policy but adverse to experimentation
Potential diversifiers	- Similar to above but even larger farms, may purchase new farms - Invest more in both agricultural and non-agricultural items - Influenced by policies, willing to adapt and experiment
Agribusinessmen [sic]	- Very large farms, high indebtedness and investment in the business - Farming background and education - Favour experimentation and modernisation - Full use if all kinds of policies - mainly productivist ones

Non-agricultural land-uses have in general received less attention in the literature. One of these few studies, set in Denmark, looked at farmers and other land-mangers in relation to afforestation schemes in Denmark, and found 5 different types of landowners: agricultural producers, non-agricultural producers, soft farmers, countryside residents, and amenity residents (Madsen, 2003). Their research reaffirmed the idea that economic rationality is not the only driver of behaviour, for if this were the case subsidised planting would have been more widely adopted.

Their study also suggested that pro-nature conservation orientation increased was linked with an increase likelihood of tree planting. This highlights a need to understand attitudes to nature and land-use, not just to understand existing business models. This is reiterated by another study also focused on forestry, just released, which has focused on barriers to tree planting in the North-east area of Scotland (Stubbs et al., 2010) and found one major hindrance was a negative perception of forestry. In addition, there were several significant economic barriers, including; transaction costs, poor relative returns, cashflow and liquidity constraints, and other less tangible constraints such as capabilities and confidence. A preference for stability and flexibility was also desired, with policy stability a key concern. This mix of economic and attitudinal barriers could well be relevant to adopting any other changes in land-management practices, such as adopting water measures.

A typology of land-uses which encompassed multiple types of land managers was recently developed by Sutherland (Submitted 2010). Sutherland argues that land-mangers can be divided into four coherent groups, based on their agreement with environmental objectives and aspects of their business model, plus one other mixed set (a summary of which is presented in Table 8). Some key aspects found were similar to those suggested by farmer typologies (e.g. influence of profit orientation, tradition and education-level) but her study also suggests that feelings of social responsibility could be a big factor influencing decisions about adopting new environmental behaviours. Sutherland's study was based in Scotland and so have specific context-relevance for the Dee case study. Even more context-specific are the preliminary results of an ongoing PhD study into AES adoption which is focused on the Dee catchment. On the basis of 30 interviews with decision-makers for land-use across the catchment, estate managers, small-holder farmers and tenant farmers were found to hold distinctly different views, with the latter the most opposed to adopting new environmental measures, and estate-managers, who managed the most land, the most willing (L.-M. Lozada-Ellison,

Pers.Comm.) These three groups are likely relevant for selecting participants for workshop in the Dee catchment, but the general issues of tenure, size of land-holding likely have wider relevance.

Table 8 Different groups of land-managers identified in relation to different attitudes to adopting pro-environmental behaviours, and their key characteristics. Adapted from Sutherland (Submitted 2010).

Category of land-manager	Characteristics
Ecological land stewards e.g. many farms	• Feelings of ecological and environmental responsibility, and stewardship a priority • High level of satisfaction with standard of living. Family involved in decisions. • Some businesses run for profit, but main concern just to break even • Low reliance on government subsidies and environmental schemes of all groups. However, majority attend training and demonstration events
Economic land stewards e.g. some farms and forestry	• Feel environmental and ecological responsibility, diversification favoured: seek to improve both the business and the land. Limited social considerations. • Strongly profit oriented. Low satisfaction with standard of living. • 40% participate in environmental schemes, usually if it brings income • Low satisfaction of standard of living
Multifunctionalists e.g. some long-standing Scottish estates	• As above have diverse motivations and businesses, including environment, business and social considerations • Highest level of dependency on government subsidies and participation in environmental schemes • Embedded in local community, involve family in decisions, but low satisfaction with standard of living.
Community stewards	• Focused on social responsibility. • More had been to college • Low levels of satisfaction with their standard of living • Many inherited business, and involved family in decisions
Other e.g. some farming, forestry and crofting	• No strong agreement social, environmental or business priorities, seemed passive – No strong attitudes or priorities. • Relative newcomers to communities, family less involved in decisions. However, may make decisions based on established practices or traditions. • Diversified enterprises, many less profit-oriented.

Taken together, the typologies of farmer and land-manager behaviour suggest some of the key intangible cultural aspects that may influence adoption of environmental behaviours are personal perceptions of business models, and perceptions of environmental and social responsibility. Risk aversion, family and connections with the community and tradition may also matter (Miller et al., 2009). Some more tangible and economic factors included tenure, financial incentives, size and diversity of existing enterprises. It is unknown whether these apply to the implementation of water measures, or to implementers who are not land-managers.

Capacity to change model

To our knowledge, there are no existing models of water-related behaviour. However, the review of the previous section, and consideration of what is known of more general pro-environmental behaviours, suggest that there are potentially a wide range of social and economic influences and constraints on behaviour. All these influences must be considered when developing a model to understand adoption of water measures.

Dwyer et al (2007) developed a broad conceptual model of farmer behaviour as a result of investigation into how best to encourage and enable long-term positive behaviour change in land-managers, at the request of DEFRA (the UK Department for Environment Farming and Agriculture). It was focused on voluntary change in behaviour after receiving advice, although in practice financial incentives and regulations were important too. The study had two stages: firstly, a full review of existing theories and knowledge relating to advice provision and behavioural change (Burton et al., 2006) and secondly, an examination of the effects of five existing advisory schemes in England. The final conceptual model was informed by both the literature review and the case study analysis. Given awareness of a new environmental measure, it describes seven types of capacity needed to adopt it: the absence of any of these acts as a barrier to change. Their focus was on not only behaviour with

respect to water, but also the related issues of soils and waste. In this study we will see if it is useful when focused on adoption of measures for the water environment.

The model contains seven characteristics, shown in Figure 7 and summarised below.

1) Farm characteristics

The data suggested that key factors were the i) biophysical setting, ii) geographical situation, iii) size and shape, iv) ownership, and v) existing infrastructure.

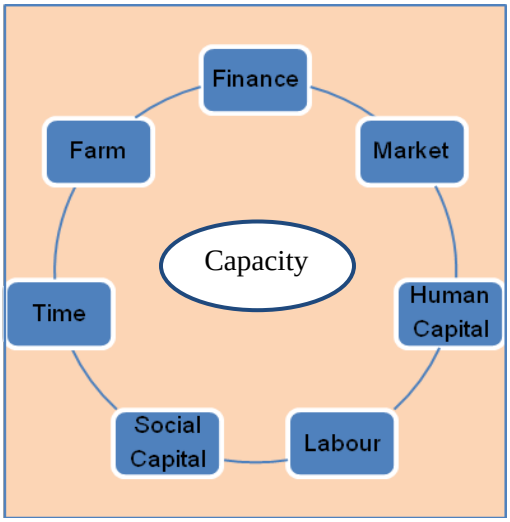

Figure 7 The conceptual model of constraints to pro-environmental behaviour by farmers, developed by Dwyer et al. (2007).

i) Key biophysical factors affecting options available were farm size topography, climate and soil composition. The interviewees knew their local environment well but were concerned about how it would be affected by increased storms and/or drought, and how this would affect land and water management.

ii) Geographical location had an important effect on access to agri-environment schemes and/or product markets dependent on spatial proximity as well as the potential for diversification. These opportunities are relevant because they are all potential sources of income that can enable farmers to adopt more environmentally friendly farming practices.

iii) The size of enterprise and size/shape of the fields were important since they dictated what was practically, technically and economically feasible. For example, fencing riparian zones was not seen as practical if it made managing stock difficult. Some techniques are more time consuming to apply if an enterprise consists of several parcels of land that are not spatially contiguous. The existing farming system also influenced change, since it was not possible to combine some practices with pre-existing enterprise mixes.

iv) Farm ownership was important but somewhat unpredictable in its influence: in some cases intra-family power struggles could block innovation, whilst in other cases the family dynamic promoted positive behaviour. The relationship between tenant and landlord was similarly complex, and could both promote or hinder adoption.

v) Many measures require some kind of new physical infrastructure (farm machinery, buildings, and fences). Where there was already existing infrastructure, farmers felt more easily able to respond to advice than those who would have to invest in new infrastructure (grant aid may make infrastructure less costly, but not free). For example, some interviewees adopted reduced tillage techniques when they were replacing equipment but those who had made conventional machinery investments were unwilling to replace them. Larger enterprises with greater turnover are also more likely to be able to afford infrastructure improvements (versus marginal family farms, particularly small dairy). Without capital, it was feared that regulatory and market trends could lead to debt and make ultimately farming unviable. A heartfelt complaint was that advice is useless if it is telling you to buy a large new slurry store and you simply haven't the capital.

2) Financial capital

Obviously, changing practices that need new inputs of labour, materials, infrastructure or training are dependent on access to finance. Many farmers in Dwyer et al.'s study experienced significant financial constraints, particularly mixed and livestock farmers. As a result anything free was seen as more attractive (although this alone would not guarantee uptake). Adoption of new practices was seen as risky and could only be afforded by the rich. Some farmers were engaging with environmental schemes to increase income, but any farmer under financial pressure was thought unlikely to outlay money on practices with only long term and/or non-monetary benefits. However, where the farm was

a secondary business – the lack of financial aspect could equally lead to disengagement with advisory or incentive schemes.

3) Market incentives

One of the major drivers for adopting environmental farming practices was access to commercial markets through quality assurance. Although farmers disliked the surveillance and paperwork involved, complying with standards laid down by quality assurance schemes and/or individual retailers, was perceived to be one of the main reasons for adopting certain practices. In these cases, the financial benefits were seen to outweigh the costs (human and social as well as financial) associated with changes. Access to these schemes could be seen as a pre-condition for some forms of behavioural change. Sometimes these schemes encouraged further change: in the National Trust case study, access to the National Trust's marketing expertise and market outlets was an important factor in generating farmer engagement with new value-added enterprises.

4) Human capital

Many farmers in Dwyer et al's study had received further or higher education. Other experiences could supplement formal education, as some were linked with ongoing academic and industry research trials, whilst others had worked or visited farms abroad and used international experience to adapt their farming practices. However, very few farmers had any formal environmental management training, learning about this 'on the job'. Running a farm is a very complex business and coping with this was seen as helpful for accessing and managing opportunities for environmental friendly practices. Advisors – as long as they provided new and context-relevant information – could be seen as useful. Inexperience of advisors, or indeed of staff on-farm, was a problem. Aside from education, identity as a farmer, and the fundamental motivation for going into farming were also influential.

5) Labour

The reduction in available (or affordable) labour was often a trigger for changes in farm management practices towards those that are less labour intensive. Reducing labour to cut costs meant that many farmers they did not have time to carry out the environmental improvements they would like to (including maintaining ponds and wetlands, managing riparian woodland). Lack of time also reduced opportunities to pass on information to others. In many cases, farmers regretted the lack of additional, trusted labour input to their businesses and felt it reduced their capacity to research and develop new ideas. Temporary farm labourers, especially if from overseas, may have different understandings of environmental management, and contracting out work was often by even greater difficulties in controlling activities (for example slurry could be sprayed more often than in a farmer's management plan).

6) Social Capital

Informal farmer-to-farmer pathways could be important for receiving and consolidating information and advice. It was perceived that networks were fragmenting and social capital decreasing. Those socially isolated from other farmers lack information and are more immune to social influence. Some farmers are members of a cooperative, buying ring or informal 'circle of friends' and this allowed them to manage their enterprises more effectively and/or economically than as an individual. The existence of such groups not only provides information pathways, but also increases the capacity of these farmers to share the risk and the expense of trying new practices, learning from and influenced by the experiences of others.

7) Time

Time issues were linked to the availability of labour, the farming system, off-farm employment (or diversification businesses) and the size of the property. The complexity of farm management, official forms and policy and regulatory interactions, all required time. Farmers who felt short of time were therefore less likely to read material, attend meetings, talk to neighbours or attend group meetings. Even those interested in changing practices could be constrained by time to only focus on the bare essentials of modern farm business operational requirements (e.g. keeping up with legislative requirements).

Developing the conceptual model for this study

The model by Dwyer et al requires modification for use in this study, before considering the input from participants in the two workshops.

Therefore, the modified model (Figure 8) is hereafter referred to as the 'capacities model'.

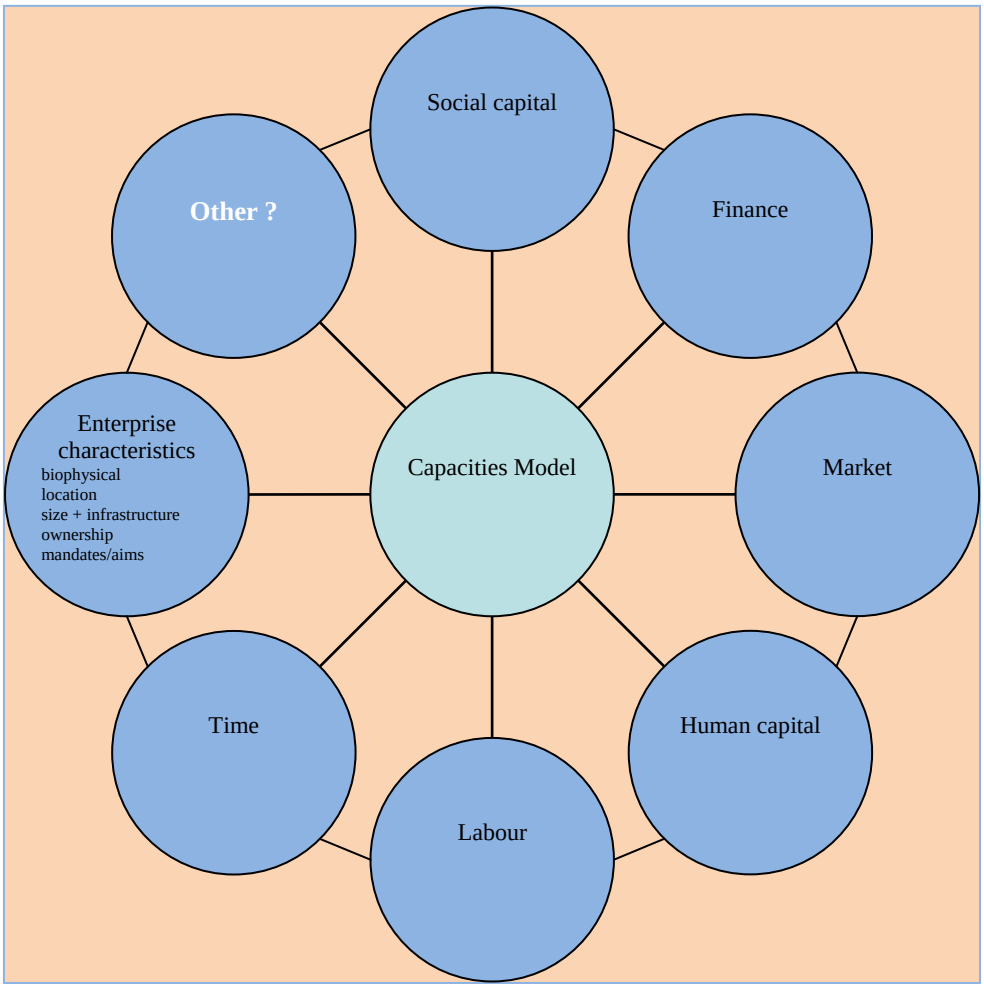

Figure 8 The 'capacities' model used by this study, for testing with catchment workshops. The capacity-types are adapted from those proposed by Dwyer et al (2007).

Looking beyond farmers to all land-managers

Some of aspects of the seven types of capacity in Dwyer's model were clearly very specific to farmers. Can the model be applied to other land-management interests, or even to others who implement measures for the water environment?

It may be reasonable that many of the issues influencing farmers are general to all land-management decisions. For example, money, time, and market pressures influence every enterprise. Whether labour is an issue, or at least the details of labour, is perhaps likely to be less similar, since for example the issues of new influxes of migrant help are particular to farmers. Revision of the model should consider whether each category warrants equal importance, the links between categories, and whether any other categories are missing but when looking beyond farmers to all land managers.

Considering all implementers

Many of the other actors whose actions influence the environment are rather different in being large, public agencies or utilities. In particular, the organisations that supply drinking water and treat

sewage are nearly always state-owned and controlled (and is the case in Greece and the UK). It may be useful to try to apply the model to these organisations, particularly as reminder that it is not only financial constraints that may influence the actions of a large organisation, even one with a public mandate. For example, it is conceivable that lack of personnel experienced in implementing measures may contribute inertia towards adopting new measures. However, there should be more caution in assuming that the conceptual model will apply to these types of implementers of measures. Public actors may have state-authorized powers, but they will also have particular mandates or responsibilities that differ to private actors' concerns. Although minimising costs may be a concern, unlike a private enterprise, the main concern may to reach targets or provide services mandated by law.

Pro-environmental behaviours

Dwyer's model was developed to explain barriers to general pro-environmental behaviours, whereas this project will be concerned with those specific to the water environment. However, there is no reason to think that the relevant incentives and constraints are likely to markedly differ between these two domains of behaviour. However, this point can be checked during the workshops.

At this stage it is evident that the label of farm characteristics would obviously not be relevant to estate managers, forestry interests and other land-managers. However, some of the issues described under this category could equally well apply to some other types of business. For example, biophysical setting could for example affect potential for moorland, forestry or other land-uses, geographical location could affect potential for tourism activities, land ownership, size of land parcels, and existing infrastructure could equally well be relevant to the decisions of an estate-manager as a farmer. Farm characteristics should therefore be relabelled "land characteristics". All previous characteristics within this category seem potentially relevant, although whether they are exhaustive, and their relative importance needs to be checked in workshops with land-managers.

Theories of land-manager decision-making

The capacities model inherently covers a wide range of possible influences on behaviour. It places less emphasis on some details which have been found in important in particular individual studies: for example, personal career paths and family views were found key by Farmar-Bowers (2009); the typologies discussed by Slee et al. (2003) suggest that those who already have a diversified business are more likely to be willing to adopt new practices (which may include pro-environmental measures). It is important that testing of this model is alert to the details of the different capacity-types, and prepared to reconsider the importance of the various constituent factors that participants identify as barriers to adopting measures.

Local relevance to the case studies

The capacities model was developed in the UK context, but are the seven capacity-types conceptually relevant to all settings? The socio-cultural context of the Louros case study in Greece will differ markedly from the UK, as well as the bio-physical environment. Furthermore, land-types and management practices are particularly variable across the UK, and the devolved Scottish government means the Dee's administrative context is distinct to that of non-Scottish regions. Therefore, cross-cultural compatibility of the model is not assumed, and the perceptions from each workshop will be compared.

Table 9 Preliminary identification of the characteristics of the case study catchments that are relevant to the capacity-types relevant to the conceptual model. For each catchment, the private land-managers are separated from public agencies, since their characteristics may vary considerably.

	Dee Catchment, Scotland	**Louros Catchment, Greece**
Enterprise characteristics	**Private, land-management** Farming: Livestock, dairy, arable, mixed. Size of holding varies, linked to ownership. A mix of tenant and self-owning farmers. Estates contain a mixture of land uses (e.g. farming, sport, forestry). These land-holdings are typically larger than farms. **Public implementers** Large forests are generally held by the Forestry Commission Scotland, managed for multifunctionality, incl. recreation. Some land mandated for nature protection and/or held by SNH. Scottish Water has responsibilities to provide potable water and treat sewage. Extensive presence and rights to water, but little land-holdings. Scottish Water supplies 79km^2.	**Private implementers:** Typical Family farming and livestock. Farming orange tree and olive oil plantations, vegetables and corn on arable and mixed farms. Small to medium size of holdings with considerable fragmentation. Livestock sector with significant hog farming, poultry and bovine raising activity. Significant intensive and extensive fish farming in the uplands and the lagoons respectively. Food processing industry present. **Public implementers:** include the Ministry of Food and Agriculture, the prefectural, regional and municipal authorities responsible for providing irrigation water, potable water and managing sewage systems. The Public Power Corporation (DEH) operates a hydro power plan in the catchment.
Human capital	**Private, land-management** Some farms and estates are family run. Mixed educational achievement. Farming identity may be linked to attitude to adopting new practices. **Public implementers** Not known	**Private, land management** Mixed and rather low educational achievement among the farming population especially in the upland of the catchment. **Public implementers** Not known.
Labour	**Private + Public** Lack of skilled local labour known to be a problem in northeast scotland.	**Private + Public** Labour skills not known.
Social capital	**Private, land-management** Some although by no means all farmers are members of NFUS, which has farmer meetings. There are some buying rings (e.g. RingLink, a machinery ring) and a demonstration farm at Ballater.	**Private** Strong bonding social capital and lack of bridging capital.
Time	**Private + Public** A consequence of labour, enterprise characteristics etc	**Private + Public** Not known
Financial capital	**Private, land-management** UK farms have relatively low levels of indebtedness (Franks, 2009) and easy access to finance (e.g. Benjamin & Phimister, 2002). **Public:** All public agencies liable to budget cuts in current economic climate. Most have no power to raise additional revenue.	**Private, land-management** Most farms with high leverage. Food processing industries with high levels of indebtedness. **Public implementers** Public agencies under severe budget constraints with no power to raise additional resources.
Markets	**Private, land-management** Linked to geography: westerly landowners relatively remote from population centres + markets access. Organic market small but growing until the recession. However tourism throughout the Dee. Opportunity to participate in Quality assurance schemes for meats, cereals and by supermarkets. **Public** Not applicable? e.g. water supply market is not open to competition.	**Private, land-management** Markets for agricultural products mainly local and for food processing mainly national (small quantities exported).

Testing the model: issues raised in workshop discussions

The issues arising in the Dee and Greece workshops are both listed below (based on REFRESH deliverables 1.14 and 1.15).

Dee catchment, Scotland

1) **Markets and incentives.** A major driver in all land-use decisions is market prices for different products, combined with income that could be received from incentive schemes.
2) **Business characteristics.** Three linked characteristics were mentioned in particular. Firstly, the size of a land-holding was important, since larger enterprises might have more skills, but equally greater efficiencies could mean less time to implement environmental actions. Linked to this was the quality of existing infrastructure. It was thought tenant farmers without their own land-holdings may have less interest in some practices, whilst age and planning timescales could affect interest the environmental activities by owners.
3) **Finances**. Changing practices often incurs costs or requires new infrastructure. Even practices which are subsidised by incentive schemes may not be taken up if the reward is not guaranteed, or there is a long lag in payment.
4) **Time.** Closely linked to labour. Carrying out recommendations takes time, and it is also required to understand the complexities of policies, or apply for any incentives available.
5) **Labour.** Most recommended actions require somebody available to do practical work. For any business, reducing labour can cuts costs, but may also be enforced by reduced availability of contractors and apprentices. This means there is not time to carry out the actions, especially if they do not directly benefit the enterprise.
6) **Skills and experience (**human capital**).** Formal and informal education, training and experience can all provide expertise useful for mastering both the practical skills and paperwork savvy needed to implement some recommendations.
7) **Social networks** (social capital**).** Networks between land-managers, perhaps mediated by particular forums and organisations, can allow for sharing of ideas and experience, and rapid coordination of new activities.

It also became apparent that some issues – such as lack of time, labour and money – were closely linked. In addition, some other points seemed important:

1) **Environmental context and variability** was often mentioned– for example unpredictable changes in weather during a burning operation limits ability to comply with the muirburn code
2) **Personal interest** was suggested by some a key underlying factor all other changes;
3) **Paperwork and complexity** seemed an emergent theme both from participants' comments, and our own review of the policy documents before the meeting.

Louros Catchment, Greece

1) Business characteristics The type of business i.e. agricultural, livestock, fish-farming, manufacturing or energy is particularly relevant, since different measures and actions apply to different business types with different requirements and difficulty degrees in implementation. As regards farming, the size of the enterprise and fields, the location of the farm and the farm-ownership were identified as more significant. Evidently, family-owned farms persisting in conventional farming practices and small enterprises with fragmented plots located in mountainous areas face substantial constraints and obstacles in taking up specific actions.
2) **Financial capital** Financial constraints were widely recognized as a key factor underlying almost every attempt of both private and public sectors in planning and implementing policies. This factor primarily refers to costs incurred by farmers and other stakeholders in changing practices, such as costs of new irrigation infrastructure and labour. Importantly, the effective operation of management and monitoring mechanisms also require financial resources in all stages of planning, implementing and supervising actions. It was admitted that

the TOEBs of the area would operate in a more efficient and systematic way if they had adequate and continuous funding.

3) **3) Markets and incentives** It was widely noted that imports of low-priced agricultural products make it difficult for domestic products to be competitive as well as profitable. Market prices along with incentive schemes play a key role in implementers' decisions on changing practices and adopting new environmentally-friendly measures.

4) **Labour** Enterprises that are owned and run by families usually face constraints in labour availability. Given the fact that many changes in practices and implementation of new measures require practical work, labour constraints may result in lags and even non-uptake of actions.

5) **Time** Closely related to labour, time was considered an additional obstacle in adopting actions. This factor is not only relevant to the implementation phase of a policy. Obtaining information and knowledge on specific measures and incentive schemes, as well as applying for such schemes may be particularly time-consuming.

6) **Skills and experience** (human capital) Most land managers in the area have not received higher education or systematic specialized training. Knowledge on farming practices is mostly acquired on an intra-family base via practical work and time experience. As a result, limited skills in applying new practices and dealing with all the required paperwork together with inadequate management skills can hinder implementing actions and changing behaviour.

7) **Social networks** (social capital) Agricultural, livestock and fishery cooperatives as well as other associations in which various interested parties are involved were considered important in sharing ideas, information and knowledge on specific measures and implementation procedures and techniques. Informal networks and meetings with local people could also help the implementers to take into consideration social dimensions in their decisions to uptake actions.

8) **Paperwork and complexity** This factor is linked to the time issue since some measures and incentive schemes are particularly complex and require considerable amount of time and effort to acquire information, provide the relevant documents and apply for incentive schemes. All this paper work and bureaucracy involved in the adoption procedures constitute a considerable obstacle especially for farmers with low education levels.

9) **Personal interest** Personal interest was identified as a key driver of all decisions and actions. Environmental and social considerations would always come second when making business decisions and choices in this area which faces a rather severe agricultural adjustment process. Personal interest along with narrow-minded thinking and low-level education appeared to be associated with strong opposition and reaction to new technologies and strong reluctance to abandon outdated and less environmentally friendly practices.

10) **Environmental variability** This issue refers to weather conditions and unexpected environmental changes, namely exogenously determined factors that may hinder or help the uptake of actions. However, this factor was considered of much lower significance relative to the aforementioned ones.

From the above issues, business resources (labour, human and financial capital) and market prices were considered most significant, with financial constraints widely identified as the principal barrier in changing practices and uptake of actions. Additionally, another issue was raised and highlighted as being particular relevant to the Louros case.

11) **Failures** in **monitoring and auditing systems** were basically considered responsible for fragmented and partial implementation or even non-implementation of measures. Deficiencies in administrative and management structures of competent authorities appear to significantly hinder the effective operation of monitoring and control mechanisms encouraging deceitful behaviours.

Final conceptual model

On the basis of the two catchment workshops, the conceptual model proposed beforehand (page 30) has been revised. Two issues have been added from the original proposed model. Firstly, environmental context was added because it was seen to be as significant as business or enterprise characteristics in determining or constraining behaviour. Secondly, institutional context was added. In Greece the absence or failure of monitoring and auditing systems was bemoaned, and in Scotland, the complexity of the systems making recommendations and providing incentives for measures was seen to be prohibitive: in both situations (though in different ways), the institutions relevant to governing water management were relevant. Lastly, a sub-issue of personal interest has been highlighted as part of human capital, as anyone with a strong interest in the environment may be motivated to acquire skills and resources that allow them to take action for the environment.

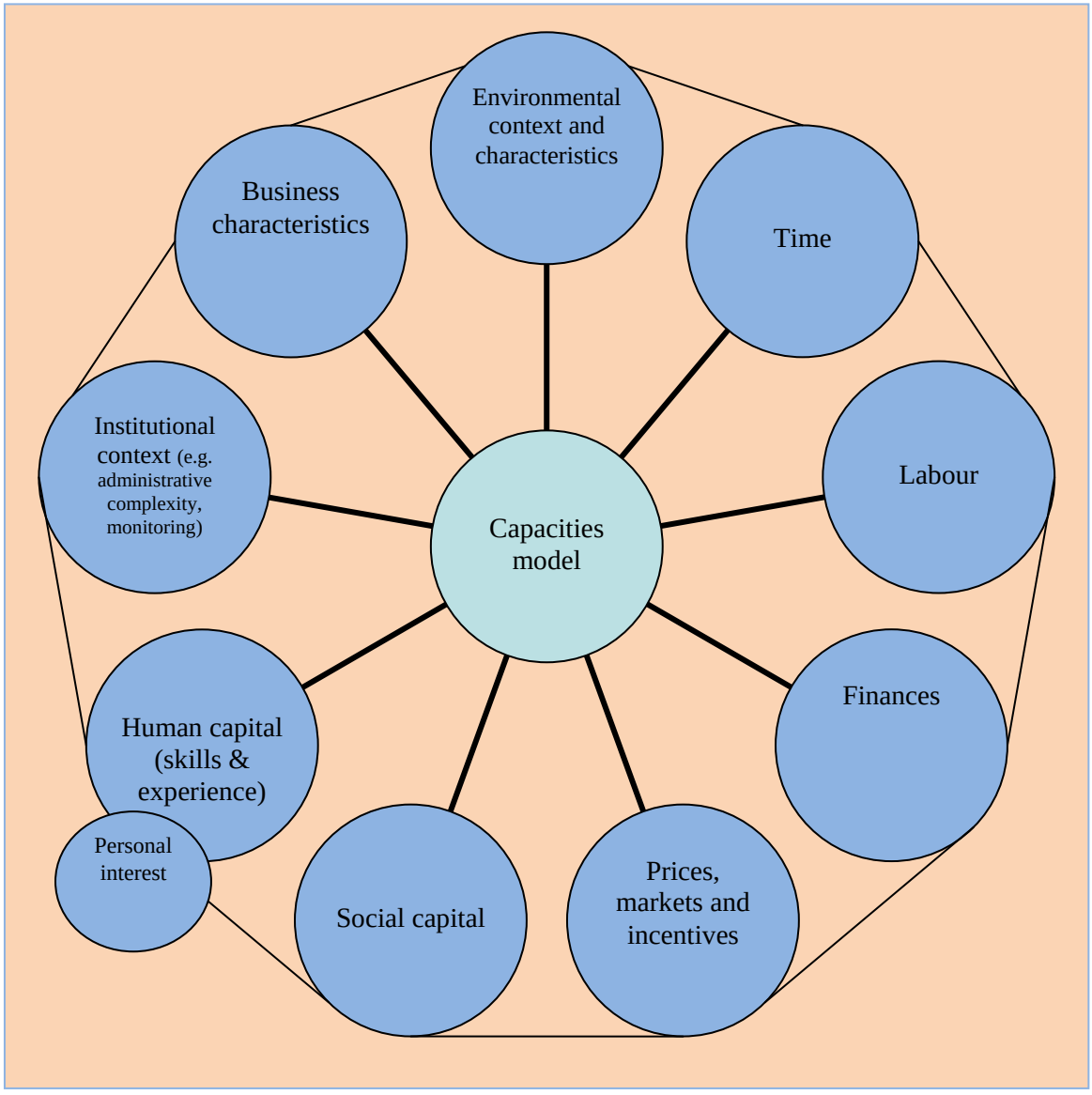

Figure 9 The key issues which can help or hinder uptake of actions recommended for the water environment.

Conclusion

The model proposed by this study fulfils the objectives of REFRESH WP1.3 task 2. This project has identified some of the key capacities of private individuals or organisation that are required for adoption of new pro-environmental behaviours, such as implementation of measures under WFD. These are represented in the final model. This model should be applicable in a wide range of situations, when considering what enables or constrains the behaviours of a wide range of actors who influence the water environment. It is relevant to considering feasible measures for cost-effectiveness modelling in REFRESH WP6. More broadly, it is also relevant to policy-makers seeking to influence adoption of measures, or recommending new measures.

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