SEVENTH FRAMEWORK PROGRAMME

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THEME 6: Environment (including Climate Change)

REFRESH

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

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Abstract

The Refresh research project aims at helping to design cost-effective management strategies to ensure freshwaters comply with the EU Water Framework and Habitat Directives.. Task 3 of Work-Package 6 is concerned with scoping possible mitigation measures to improve water quality through collaboration with local stakeholders. In this context, a stakeholder engagement process has been designed and developed in the project's six demonstration catchments. In this context, a number of workshops aimed at identifying and discussing mitigation measures at the sub-catchment have taken place . This Deliverable summarizes the methods and findings of these workshops held between March 2011 and April 2012.

Workshop participants were chosen following the guidelines devised within WP6 (Varjopuro et al., 2011) and comprised farmers, nature conservation and regulatory agencies, representatives of the water industry and other industries (fishing, quarries, etc.), officials from municipalities, etc. Workshop followed the common guidelines, but their design was also influenced by context-specific factors and characteristics, as well as catchment and sub-catchment needs. In all cases workshops addressed the same aims, namely i) the identification of measures for mitigating water quality problems at the local level; ii) gathering local stakeholder views on the catchment problems and the effectiveness of identified measures under current and likely future climatic conditions.

Discussions showed that nutrient pollution was the most widely cited problem generally in all sub-catchments, while agricultural activity and sewage treatment were identified as the major sources of pollution. Identified problems had often a contextual perspective, while other sources of pollution diverging from common trends include fishery management of ponds (CZ), housing developments and private septic tanks (Thame), forestry, quarries, septic tanks and the increase in the number of migratory geese (Dee). Divergences in contextual factors and in the feasibility, scope and perceived effectiveness of mitigation action, led to the specification of a significant variety of solutions, proving that there is not a common path to compliance.

Workshop participants were able to develop a consensus on the potential effects of climate change. On the other hand (with very few exceptions), stakeholders seem to have a rather contemporary perception of conditions and cannot project solutions in the form of "climate change proofing" of mitigation measures. Also, in some cases, other issues (such as future developments in agricultural policy) were perceived as being more immediately important compared to climate change. This finding indicates the need for more coherent and rigorous efforts by policy makers (as all levels, i.e. international, national, regional, local) to raise awareness and initiate the detailed investigation of climate change response options.

1. Introduction - the role of stakeholder engagement in WP6

The REFRESH project aims to help design cost-effective adaptation and mitigation strategies for freshwaters to comply with the Water Framework and Habitats Directive, taking into account expected future impacts of climate change. A key dimension of the project is the ascertaining of lay knowledge(s) of water quality challenges, compliance challenges and local actors' perceptions of cost-effective interventions. Task 6.3 is specifically concerned with scoping possible adaptation and restoration options for water quality improvement in collaboration with local stakeholders at the sub-catchment level.

With that purpose, a stakeholder engagement process has been designed and developed in the project's six demonstration catchments. In this context, a number of workshops aimed at identifying and discussing mitigation measures at the sub-catchment have taken place in Scotland, England, Finland, Norway, the Czech Republic and Greece in the period from March 2011 to April 2012. The workshops were designed and implemented following the *Participatory Assessment of Adaptation Strategies* protocol agreed in WP6 (Varjopuro *et al.*, 2011), and built on (and relate to) several other parts of the REFRESH project in the following way:

- The workshops were designed to build on WP1 work on the potential mitigation measures for water quality problems and the conceptual model of stakeholder views of measures and potential barriers to uptake (Deliverable 1.16)
- Previous WP6 findings on identification and sources of pressures at the sub-catchment level (Deliverables 6.1 and 6.2) informed the stakeholder discussions and were used to contrast local views with scientific findings
- Climate change aspects of the workshops build on the climate change scenario work develops in WP1 (Deliverable 1.6).
- The outcomes of the workshops in terms of perception of cost-effectiveness and their adaptation under climate change will be used to inform the modelling of cost-effectiveness of measures in the linked work between WP6 and WP5 and will feed into Deliverables 6.11 to 6.16.
- The outcomes of the workshop in terms of identification of measures to mitigate water quality problems at the sub-catchment level will be used as a basis for the identification of main cost-bearers and beneficiaries of water quality improvements to inform disproportionality analysis (feeding as well into Deliverables 6.11 to 6.16) and the flagging of wider benefits (feeding into Deliverable 6.17).
- The outputs of the workshops and the links established with local stakeholders feed into REFRESH general Stakeholder Engagement/Collaborative learning process (WP7, Task 2).

A key part of the WP6 approach has been to identify sub-catchments in which different conditions appertain, to enable the diversity of the catchment conditions to be captured. This diversity is also reflected in the stakeholder engagement processes that, while sharing the same principles, have taken different operational approaches adapting to the local circumstances. This document summarises the key elements of each of the participatory processes undertaken as part of Task 6.3 and provides a comparative analysis of the results across the six different

demonstration catchments. Full description of each of the stakeholder engagement processes and their detailed results can be found in the original reports (Martin-Ortega *et al*., 2012a and 2012b; Pelkonen *et al.,* 2012; Políčková and Svejdarova, 2012; Skarbøvik, 2012; Skuras *et al.,* 2012).

This document is organized as follows. Section 2 presents a brief review of the relevant literature on good practices associated with stakeholder engagement, while Section 3 presents an overview of the approach adopted in each one of the study catchments (e.g. date of event, scale of analysis, participants, etc.). Subsequently, Section 4 presents key findings from each workshop, dealing with stakeholders present, methods used, perceived water quality problems, identified solutions and climate change considerations. Finally, Section 5 concludes through presenting common and divergent trends amongst the workshops organised in the six demonstration catchments.

2. Good practice in stakeholder engagement

Stakeholder engagement is considered as a very important means of both understanding local perceptions of natural resource management problems and of contributing to elaborating solutions to specific natural resource challenges. Early examples of stakeholder participation were often based in developing countries where participatory processes were favoured as a means of more effect project delivery of externally supported projects (Chambers, 1983), but great emphasis was placed on engaging with hard to reach groups, particularly where they were targeted beneficiaries of interventions. Participation was also particularly favoured where local knowledge provided a significant input into development strategies. Leach *et al.* (2002) describe examples of stakeholders being drawn together in the US into a partnership to address major challenges of water management.

Stakeholder participation has come to be regarded as the processes 'of identifying and analysing the interests of the individuals, communities, groups and institutions that can affect or be affected by the outcome of a management intervention, in a manner that contributes fully to the process and to project design, implementation and monitoring'. It is important, however, to distinguish between stakeholder analysis in practical natural resource decision-making and in research (Leach *et al.,* 2002).

Over the last two decades the practice of stakeholder engagement has advanced, in particular in complex natural resource management contexts such as community forestry and watershed management. Kallis (2006) makes the point that stakeholder engagement is formally required in the development of river basin management planning within the Water framework Directive (WFD). Arguably, it makes sense to continue such processes in WFD-related research, where it is important to retain connectivity between research and practice and where there is a mandate to foster public participation (De Stefano, 2009)

However, as stakeholder analysis has developed in a very wide range of fields from health care to natural resource management it has been recognised that it embraces different theoretical positions and approaches (Reed 2008; Reed et al. 2009). Stakeholder engagement may be instrumental to engender legitimation of decisions, or may be more oriented to reaching a shared understanding of problems. Röling and Jiggins (1997) see stakeholder engagement as a means of negotiating difficult natural resource management problems.

Good practice in stakeholder engagement can be seen to have a number of core features. Reed (2008) argues that stakeholder participation practices should not be prescribed in a uniform process but adapted to circumstances, especially taking into account the convenience and needs of the stakeholders. A number of general principles are identified. First, it is imperative that the stakeholder engagement process is built on trust and enabling scope for learning and empowerment, where power relationships are not brought into play and all stakeholders can feel that their views are legitimate. Second, stakeholder engagement should be as early as possible in the natural resource negotiation process and not comprise a one-off event. Third, all relevant parties should be included. It is desirable to map out all those with an actual or potential stake in the resource under consideration and ensure their systematic representation. Fourth, skilled facilitation should take place. Fifth, clear objectives need to be agreed between stakeholders and facilitator(s). Finally, it is important to tailor the stakeholder engagement to the specific conditions of the encounter.

In the case of REFRESH a number of specificities existed. First, the stakeholder engagement with REFRESH was for research purposes, and could offer no guarantee of enhanced natural resource management in the foreseeable future. There were no immediate and obvious gains from the process from the side of participants, at least in the short term. Our process was essentially extractive, albeit with the intention of improving water resource management in the longer run. It was also potentially threatening to some stakeholders, particularly those implicated in polluting practices, whose future room for manoeuvre might be compromised by water resource management policy. In some of the catchments, there was a prior history of stakeholder engagement and in some cases fatigue has been identified as an issue where key stakeholders are constantly called on to be present. It was thus important for the engagement process to be neutral with respect to those managing water quality, with the stakeholders greatest 'win' from engagement being the prospect for the formal acknowledgement of their views.

3. The approach adopted in the case study catchments

The stakeholder engagement processes were designed and implemented in all countries following the *Participatory Assessment of Adaptation Strategies* protocol agreed in WP6 (Varjopuro *et al.*, 2011), but necessarily entailed different specific workshop designs for each of the catchments to adapt to the local realities. Table 1 presents an overview of the key details of each stakeholder workshop. As seen from the Table, one workshop was organised per demonstration catchment, with the exception of Vltava (Czech Republic), where one workshop

was organised in Lomnice and Skalice sub-catchments and another one in the Lipno sub-catchment. Most workshops were organised in autumn 2011.

With the exception of the Finnish workshop (which dealt with the catchment level, but with emphasis on Lake Pyhäjärvi), all other workshops analysed sub-catchment-specific conditions. In most cases, between 10-13 stakeholders, represented a broad range of actors (following the categories defined in the stakeholder engagement process guidelines of the WP6) participated. However, the Norwegian workshop, organized in the context of the WFD planning process, attracted 33 participants. Farmers were represented in all workshops, as were nature conservation and regulatory agencies. The water industry also participated in the Thames, Louros and Vansjø-Høbol. Representatives of other industries were present at the Norwegian and Scottish workshops, while fisheries representatives participated in the Lomnice-Skalice (Czech Republic) and Pyhäjärvi workshops. Finally, officials from municipalities were present in the workshops organised in the Czech Republic and Finland.

Table 1: Overview of stakeholder workshops

Country	River basin	Date of stakeholder event	Scale of analysis	Number of participants	Stakeholders represented
Czech Republic	Vltava	October 31st 2011 (Workshop I–Lomnice and Skalice subcatchments)	sub-catchment	13	Municipalities, fishery managers, farmers, regional regulatory agencies, concerned stakeholders
		November 28th, 2011 (Workshop II– Lipno subcatchment)	sub-catchment	11	Farmers, nature conservation agency, concerned stakeholders
England	Thames	April 20th, 2012	Thame sub-catchment	13	Farmers, regulatory and conservation agencies, water company
Finland	Pyhäjärvi/Ylä neenjoki	October 10th, 2011	Catchment with a focus on the Lake Pyhäjärvi	10 participants from region and 7 researchers from SYKE	Agriculture producers, municipalities, environmental protection, fishing, research.
Greece	Louros	November 23rd, 2011	Two sub-catchments (Arta and Preveza)	8	Farmers, Local Organizations for Land Reclamation (TOEBs), Amvrakikos (Natura 2000) Management Body.
Norway	Vansjø-Høbol	March 2nd, 2011	Two sub-catchments (eastern and western Lake Vansjø).	26 stakeholders, 33 participants in total.	Industry, hydropower company, drinking water supply, farmers, land owners, NGOs (environment and leisure), regulatory agencies.
Scotland	Dee	February 3rd, 2012	Leuchar Burn and Loch of Skene sub-catchment.	12	Farmers, foresters, regulatory agencies, nature conservation interests, quarry manager, local residents.

4. Workshop key features and findings

4.1 Czech Republic

4.1.1 Stakeholders' recruitment

Two workshops were held in structurally different parts of the Vltava catchment. Invited organizations included stakeholders, which either directly contribute to phosphorus pollution or are involved in solving the consequences of excessive phosphorus inputs into reservoirs. In total, 24 representatives (13 at Mirovice and 11 at Lipno) of various stakeholder groups were invited. In workshop I (Mirovice – lying in the Lomnice and Skalice sub-catchment) deputies from municipalities, fishery companies, agricultural business, as well as institutions and concerned stakeholders were present, while in the workshop II (Lipno – representing the upper part of the Vltava catchment) three groups were invited, namely farmers, institutions and mayors of municipalities. No one from the group of mayors attended; nevertheless, other stakeholders were really interested and had (especially in the group of institutions) an even more holistic view of the topic than in the workshop at Mirovice.

4.1.2 Methods used

Both workshops were introduced with a brief overview of phosphorus and eutrophication problems in the Orlík reservoir catchment. Then a combination of plenary and group work was used to formulate causes of water quality and pollution problems and specify mitigation measures for the reduction of phosphorus export from pollution sources. The workshops were completed with a follow up discussion on the topic "Why are those measures are not being accomplished yet?"

4.1.3 Perceived water quality problems

The main problem in the Orlík reservoir is excessive phosphorus loading from the catchment, which especially during the summer period is so high that algae and cyanobacteria blooms develop and exceed limits for bathing waters. Phosphorus load is the main cause of eutrophication and the key factor for the emergence of the mass of algae blooms in the reservoir. There are three sources of phosphorus pollution: (1) Municipal wastewaters (discharged to streams and rivers from registered as well as non-registered sources), (2) Fishery management of ponds, (3) Losses from agricultural areas.

From the scenario calculations of the balance study of phosphorus and nitrogen sources in the catchment area of the Orlík reservoir (Hejzlar et al. 2010) it is clear that the concentration of phosphorus without eutrophication effects in the Orlík reservoir cannot be achieved without an efficient (on average 90%) removal of phosphorus from all domestic and municipal wastewaters in the catchment and at the same time, the limitation of phosphorus losses from ponds with intensive fish production.

4.1.4 Identified solutions

All the "winning" mitigation measures are presented in Table 2.

Mirovice

In the first workshop in Mirovice the representatives of all four groups agreed on one measure (though it was not "the winning one" for all of them): to really use the existing legislation and force those responsible to act effectively and fairly. The state inspection authorities operate, but not in the same way for everybody. They are more-strict towards large enterprises (such as agricultural or fisheries) and less strict towards small companies and private persons (which would be bankrupted by a penalty). This measure can be highly cost-effective, because it costs almost nothing, but there is a big problem with its fulfilment: there is no will (either political or social) to bring this measure into real life.

For the representatives of agriculture, targeting of agri-environmental subsidies was crucial and a precondition for the other three mitigation actions selected, i.e., equality of controlling and sanctions; division of big fields, and grassing of thalwegs (runoff pathways on slopes) in tilled areas.

The group of fishermen proposed a removal of old burden of phosphorus in fishpond sediments, which is quite controversial, because it is very expensive, but there is no evidence that this measure would really help in the longer term.

The group of mayors proposed the construction of new sewage treatment plants. The emphasis was on a better system of planning and coordination within the whole river network. They were well aware of the high costs associated with constructing or repairing existing sewage treatment plants and building of separate sewer systems, but perceived this measure as essential.

The group of institutions hesitated between two measures, because the greatest effect would be reached by the construction of new and reconstruction of old sewage treatment plants, but this measure is very expensive. On the contrary, the observance of good practice is relatively inexpensive, but no one knows how this measure would affect phosphorus concentration.

Lipno

A group of farmers completely agreed on two measures suitable for this specific landscape area and conditions around the Lipno reservoir: (1) to reduce the size of cattle herds to 30–35 animals (i.e., cost-effective, very cheap measure that needs only organization and dividing of plots) and (2) to cancel out-wintering of stock in the area and convert herds to winter quarters (more expensive, needs building, but very effective for reduction of phosphorus losses). Both measures will bring a reduction in erosion and phosphorus runoff, but also can reduce compaction of soil, local soil degradation and, moreover, generate considerable benefits to farmers in the form of healthier animals and a larger number of bred calves.

The group of institutions proposed two closely related measures: (1) Building of cleaning wetlands and (2) control of non-registered wastewater releases. The first measure is rather expensive, but can solve also the problem of small settlements and villages with sewage waters. The second one is not expensive, but requires political will on behalf of responsible institutions.

Table 2: Comparison of winning measures according to stakeholder groups and sub-catchments

Stakeholder group	Sub-catchment	
	Skalice – Lomnice	Lipno
Municipalities	Construction of new wastewater treatment plants and modernization of existing ones	They were not present
Farmers	Targeted state subsidies, their long-term stability for maintenance of the landscape	(1) Reduction of the size of herds to 30–35 animals (mainly cows) (2) Change of free winter breeding of cattle in the area to a winter housing
Fishermen	Removal of old burden of phosphorus in fishpond sediments	There are no intensive fishpond fisheries in the catchment – it is not a relevant group
Institution	Construction of new wastewater treatment plants for small settlements	(1) Building of wetlands, e.g., polders, retention ponds, root zone wastewater purifying plants, broad-base terraces – there are many types of artificially constructed wetlands that can be used for retention of phosphorus (as well as for other ecological benefits) (2) Control of non-registered wastewater discharges

The above measures can be perhaps distinguished into systemic and domain/field. Systemic measures depend on superior institutions (regional, state) or on political will; domain/field measures can be directly applicable by stakeholders or institutions (Table 3).

Table 3: Generalisation of measures suggested by stakeholders

Systemic measures	Domain/field measures
Use of the existing legislation and forcing the representatives of legislation to really act (control everybody with the same criteria and impose same sanctions)	Construction and reconstruction of sewage treatment plants and regulation of disposal of wastewaters from septic tanks
Small ponds are not required to limit discharges of phosphorus, only large ponds do – to solve this situation	Dividing of big fields and/or conversion of arable land into grassland
Support to the enhancement of retention capacity of the landscape (dividing fields, diversifying of landscape, restoration of river flood plains and meanders)	Housing of livestock in the winter
Reduction of phosphorus export from the washing and dishwashing agents	Landscape revitalisation

4.1.5 Climate change considerations

In the case of the Czech Republic, climate change is anticipated to bring possible changes in terms of increasing temperature, increasing extremes in precipitation, generally lowering the groundwater table and river flow, and increasing concentrations of P in surface waters. This can influence farming, fisheries and recreation in the area, as the availability of fresh water can become a barrier on economic activities in the future. On the other hand, climate change can potentially generate high economic benefits to those managing a reservoir of fresh drinking water. Hence, stakeholders were asked to evaluate each of the measures from the climate change point of view.

The result was not so clear in terms of stakeholders' perception of possible climate change and measures. The stakeholders' perception of reality is contemporary, and not so much oriented into the future. They understand the problem of climate change and aquatic ecosystems in a way that all changes will be stronger, may be quicker, but not fatal, or unexpected. Generally, stakeholders believe that climate change should lead to different responses in environmental conditions but they do not project their solution in the form of proposed measures. Thus, they responded that all mitigation measures suggested in both meetings are also applicable in the future under possible climate change.

4.2. England

A stakeholder workshop was held in Whitchurch, in Southwest Oxfordshire, on April 20th 2012. The aim of the workshop was to explore the views of local stakeholders on measures to alleviate water quality problems in the Thame sub-catchment in the Northeast of the River Thames.

4.2.1. Stakeholders' recruitment

Due to its distant location, JHI did not have well developed relationships with stakeholders in the Thame sub-catchment, therefore in order to identify and contact stakeholders, JHI worked in partnership with the Centre for Ecology and Hydrology (CEH), who facilitated communication

with key informers from Natural England and the Environment Agency (EA), who in turn provided further guidance. A total of 24 people were contacted, of which 13 finally attended the workshop. Attendees included: two representatives of the Environment Agency, two representatives of Thames Water, one representative of Natural England and eight farmers (livestock and arable). Other stakeholders, including those from the University of Oxford, the RSPB, Friends of Tring Reservoirs and local government were contacted using details obtained online, but were either unable to come or, in the case of local government, unfortunately perceived the workshop as beyond their remit. This represents the lack of awareness of the pervasiveness of water quality issues and inter-connectedness of stakeholder actions in this particular area.

4.2.2. Methods used

The participatory method used in the Thame workshop was similar to those employed in the Scottish case study. This involved:

- A combination of plenary and break out group sessions focused on three main issues: (1) discussion of water quality problems in the sub-catchment and the sources of these pressures, (2) discussion of measures to alleviate these problems and perceptions of their cost and effectiveness, and (3) discussion of climate change and its effect on water quality and adaptation measures.
- Support material, including a two dimensional diagram with a horizontal axis representing the effectiveness of measures (from large impacts to small impacts) and a vertical axis representing costs (from high costs to low costs and even (farm) gains). The discussion on climate change used a simplified narrative of the most likely climate change scenario for this area as a basis for discussion.

A feedback questionnaire was also distributed at the end of the event and a leaflet summarizing the main outcomes of the workshop was distributed to the participants afterwards.

4.2.3. Perceived water quality problems

Participants generally agreed that the main pressures in the area included: (i) nutrient pollution causing algal blooms (ii) other diffuse pollutants causing poor water quality (iii) point source pollution generating poor water quality, and (iv) physical modification. Extraction was not perceived as a major pressure.

Regarding the sources of these pressures, besides agriculture, sewage treatment was perceived to be a major part of the problem, both sewage treatment works and private septic tanks (the growing population of 'new comers' from London who do not know about septic tank management was thought to exacerbate the problem). There was no consensus as to whether physical modification made by dams and weirs mitigated or exacerbated water quality issues. The role of regulation, and its knock on impact in generating water quality problems, was also discussed. This discussion highlighted the interaction between the policy sphere, and its impacts on the ground, and how contradictions and poor communication at the policy level were perceived to have real negative impacts on water quality at the catchment level. Urban development was argued to be the final major cause of pressure on water quality in the Thame sub-catchment. Road runoff was seen as problem, with periods of dryness and then heavy rain resulting in chemical residue build up being flushed out into watercourses. The increasing

number of housing developments was perceived as contributing to both diffuse and point source pollution, from construction dust, chemicals and run-off.

4.2.4. Identified solutions

An interesting and distinctive output of the stakeholder consultation process in the Thame sub-catchment is the emphasis that was put into the effects of regulation in water quality and the need for introducing more flexibility in its implementation.

From the list of sixteen measures identified and analyzed by participants, the measures generally perceived to be most cost effective in this area were decreased use of pesticides and crop rotation, flexibility and empowerment for farmers, regional regulation instead of national and awareness raising for land managers and farmers concerning water quality issues and consequences, and results of action. Other measures were also suggested by the majority as highly effective, but perspectives were split between high and low costs; these measures included flexible field margins, increased soil sampling, information and monitoring and improved septic tank management. As the majority of the workshop participants were farmers, it is possible to be more conclusive in regards to farm-related measures. Measures concerning water quality standards and urban development were not considered by many of the farmers, and therefore it is hard to draw valid conclusions on their potential effectiveness or cost. For other measures, such as slurry storage and restricting livestock access, no clear consensus emerged for effectiveness or cost.

4.2.5. Climate change considerations

There was general consensus regarding the impacts of climate change in the Thames Basin, in terms of changing weather patterns, generally drier hydrological conditions and increased likelihood of extreme events. Despite the uncertainty regarding the details of how the climate may change, participants were able to provide insightful and well-argued expectations about the local effects of climate change on water quality and mitigation measures, including effects for agriculture (e.g. decreased profits in dairy farming, the need for adaptation and new skills to face new conditions), for ecology and habitats (negative, such as invasive species, and positive in the creation of new habitats) and human and animal health. Exacerbation of flooding effects was also signaled as highly problematic.

Climate change impacts were also perceived in the context of a growing population, increasing urbanization, and ever increasing demands on land conflicting with rising food demand. This is consistent with the conceptual model (D1.16) in which external factors that affect capital (prices, markets) and other regulation affecting the environment (for example compulsory field margins) play a major role. Actions to improve water quality in the face of climate change might therefore be more effective were they also to address non-agricultural sources. The need to adapt the know-how and acquire new skills to deal with the new conditions provided by climate change, relates to the component of the human capital (knowledge and experience) of the conceptual model.

4.3 Finland

The objective of the workshop was to explore the feasibility of water protection measures and terms of their use in the catchment area of Lake Pyhäjärvi The workshop was intended to examine the views of stakeholders on future development of water protection as well of socio-economic trends in the region in order to determine the effects of changing climate conditions on water protection and its measures.

4.3.1 Stakeholders' recruitment

In the workshop ten participants from the steering group of Pyhäjärvi Restoration Fund attended the event together with seven SYKE representatives. The steering group consists of representatives of the food and paper industry, agricultural producers, municipalities, regional environmental authorities, academics as well as fishing and water protection organisations with an interest in protecting Lake Pyhäjärvi. In addition to their positions in organisations some of the invitees are also farmers in the Pyhäjärvi region. The steering group thus involves all the key actors with an impact on the state of or an ability to initiate water protection measures at Lake Pyhäjärvi.

No participants outside the Pyhäjärvi Restoration Fund steering group were invited, except for a person who has a long experience in water protection administration and nowadays operates as an organic farmer. Not inviting people outside of the steering group was due to practical organisational demands and because the workshop was planned to also contribute to the planning of the Pyhäjärvi Institute's future activities. No representatives of industry were present at the workshop though they were invited. Industry is highly relevant for the Pyhäjärvi region and to the water protection work implemented. This may have influenced the group discussion in the group on socioeconomic scenarios in particular as the local participants included only representatives of local municipalities.

4.3.2 Methods used

The workshop consisted of plenary and breakout group sessions. As an introduction to the workshop the objectives and structure of the session were presented to the participants. They were then introduced to background and objectives of the REFRESH project and its linkage to the workshop results. A representative of the Pyhäjärvi Institute briefed the participants on key issues in climate change and water protection in the Pyhäjärvi region including past patterns of and expected future changes in nutrient loading, precipitation and lake ice cover periods. Finally the concept and use of socio-economic scenarios in REFRESH were introduced to all participants.

The first plenary session was followed by the breakout group session. The invitees were divided into three group sessions by forehand, according to their expertise. This was done to ensure that all groups would have enough participants as well as a range of perspectives on water protection and society. The groups were:

Group 1. Agricultural production, 7 participants: Agricultural producers' organisation, municipal environmental officer/a farmer, a farmer with an earlier expertise of water protection in the public sector, Pyhäjärvi Institute, 3 participants from SYKE.

Group 2. Fishing as lake restoration, 6 participants: Regional environmental authority (ELY centre), Lake Pyhäjärvi fisheries organisation, University of Turku, Pyhäjärvi Institute, 2 participants from SYKE.

Group 3. Socio-economic scenarios group, 4 participants: 2 municipal leaders, 2 participants from SYKE.

The groups' work was based on templates. The agriculture group had a template to analyse feasibility, effectiveness and sensitivity to climate change of various water protection measures. Seven water protection measures were chosen in advance, in order to be discussed by the stakeholders in the workshop. These included:

- Vegetation cover in winter (grass or tilling of the stubble field)
- Manure-fertilising (in addition to artificial fertilisation)
- Reduced artificial fertilisation
- Reduced soil tillage, Direct seeding
- Buffer zones
- Wetlands

The restoration fishing group had the same three criteria to structure their discussion, but they focused on fishing as a lake restoration measure. The socio-economic scenario group had a different approach, as the purpose was to discuss factors influencing the region's land-use development and possible future trajectories. In this group the template focused on major land-use categories.

4.3.3 Perceived water quality problems

A risk of eutrophication of the Lake Pyhäjärvi was the water quality issue to be discussed for each group. Lake Pyhäjärvi is classified as having a *good* overall ecological status (WFD classification), but the state in the physical-chemical assessment the class was *satisfactory* due to indicators telling about eutrophication. The participants shared the view that eutrophication risk is real.

Agriculture is the biggest source of nutrients. Pyhäjärvi Restoration Fund has promoted and development water protection measures in agricultural land already for a long time. It was logical for the steering group that one of the breakout groups would focus on that topic. Also a breakout group for fishing as a restoration method follows well the activities of the foundation. In this sense, the workshop's topics were to large extent designed to fit the thinking of the participants.

In addition to the eutrophication risk, the need to manage water quantity was raised by the participants. There was a concern that flooding and occasional drought will become a more important issue in the future due to warming climate. Also the issue of quality of soil was raised.

4.3.4 Identified solutions

The group that discussed agriculture had a strong view that the currently practiced measures (listed above) should be continued and even practiced more broadly. In addition, more effort should be put on targeting the measures to the locations where they are the most effective.

However, most of the discussion on agricultural production focused rather on strategic approaches with future importance than on addressing individual water protection measures in detail. These strategic approaches included a stronger focus on water management and soil structure as well as developing organic farming.

On the water management the agriculture group concluded that field drainage during the spring and harvest season is vital to field farming in Finland and it will have a particular importance under climate change. However, field drainage increases water runoff to the lake, which may have negative impacts on water protection. Further, more in flat areas water management on a farm level may entail for instance development of controlled drainage. As controlled drainage requires a lot of financial resources and specific soil types in the region the measure was seen to be profitable in farming of certain products only (especially of special crops such as potato) but not in grain farming.

At catchment level, the water management would require flood plains for regulating transitory flood peaks as heavy rains are to become more common when the climate change proceeds.

On the soil quality and structure, the agriculture group concluded that *preventing soil compaction* is a significant economic factor as the size of farming equipment continues to increase and farming schedules become more restricted in the future. *Direct seeding (direct drilling)* reduces the need to use heavy equipment on the fields, but it requires good soil structure and drainage.

Organic production was perceived as an important strategic development trend for the region. In order to develop organic production it would be necessary to set apart the subsidies for organic production from the general development of the agri-environmental subsidy scheme.

The group that focused on fishing had a view that fishing is an effective lake restoration method. It helps to reduce phosphorus levels but its most significant effect on the state of Lake Pyhäjärvi results from its impact on the food chain. A condition for a continuance of restoration fishing is that professional fishing remains profitable. Profitability could potentially be improved by developing the marketing and processing methods for lower-value fish species as well as with the price of natural fish continuing to grow.

Climate change may complicate restoration fishing that is currently dependent on ice coverage. The group was confident that by developing techniques used in fishing. It is, however, possible to adapt to the challenges climate change poses for restoration fishing.

The third group discussed future development of land-use in the region. Its discussion was not oriented towards water protection measures. The two municipal leaders in the group had a common understanding the agriculture will remain an important land-use also in the future. They also shared a view that the region's agriculture will become more environmentally friendly in the future, but that some negative impacts will still occur. The groups 'solution' for the future was to continue the presently strong collaboration among agriculture producers, local food industry and the Pyhäjärvi Restoration Fund.

4.3.5 Climate change considerations

In the discussions it was brought up that the climate change will probably cause changes in the nutrient loading pattern to Lake Pyhäjärvi. The participants referred to agriculture scenarios developed in a recent research project that concludes that generally the total loading to Lake Pyhäjärvi would increase with climate change. Loading would increase particularly due to the increased length of growing season. Moreover, the seasonal distribution of nutrient loading is likely to change more significantly due to climate change than the amount of total annual loading. In the future a higher proportion of loading will be induced during the autumn and winter seasons.

If climate change will increase the length of the growing season and winter temperatures, the use of autumn seeding crops will become more common. This would increase the length of vegetation cover period, which may reduce nutrient loading to the lake. However, mild winters with heavy rainfalls may considerably increase loading simultaneously. As plant pathogens are likely to proliferate also, soil tillage techniques would need to be modified in the future. This might suppress the need for ploughing, which currently is vital for instance for the production of malting barley.

It was also pointed out that the future increases and decreases of loading are not related only to climate change but are largely dependent also on the directions to which agriculture is developing. The impacts of climate change on water bodies are thus indirect and subtle and associated with both agricultural and human activities.

For restoration fishing climate change can cause serious challenges as mentioned above.

4.4 Greece

A stakeholder workshop was held in the Louros municipality, on November 23rd 2011. The purpose of the workshop was to discuss with major local stakeholders alternative mitigation measures in terms of their scope, feasibility and effectiveness, in order to identify potential remediating schemes for the Louros sub-catchments to deliver compliance with WFD under alternative climate change scenarios.

4.4.1 Stakeholders' recruitment

Water quality problems in Louros are specific to nitrification problems in the sub-catchments of the Arta and Preveza plains, and phosphorus pollution being particularly relevant to the Arta sub-catchment. Thus, the identification of stakeholders to be engaged in the discussion about potential mitigation/adaptation measures should focus on water quality issues and major drivers in the Louros sub-catchments related mainly to agriculture and livestock activities.

To proceed with the stakeholder identification procedure, the classification proposed by Varjopuro et al. (2011) based on the degree of the stakeholders' power and interest with respect to the specific problem(s) was adopted. Given the specific non-compliance issues at hand for the two sub-catchments (high levels of N and P observed), farmers were identified as the key actors to be invited to participate in the workshop. Also significant is the role of the Local Organizations for Land Reclamation (TOEBs) of Preveza and Arta which are formed by farmers and have the responsibility for maintaining and extending all land reclamation projects in their area including

irrigation, drainage and roading. Thus, a deputy of the TOEB of Preveza and representatives of Arta TOEB were also invited to participate in the workshop. Finally, two representatives of the Amvrakikos Management Body -the public non-profit organization being responsible for the administration and management of the nature and landscape of the Amvrakikos Gulf- were invited to attend the workshop.

All the invited stakeholders attended the workshop; that is a total of eight individuals. Since most of the participants had a farming background sharing common or similar interests, no particulars conflicts or tensions were apparent. Also, the fact that all participants shared the same views on the sources of non-compliance in Louros facilitated a "consensus" environment.

4.4.2 Methods used

The workshop consisted of one plenary session. Discussion focussed on agricultural practices. A set of water protection measures was selected in advance, in order to be used as a starting point for the discussion. The choice of the particular measures was based on the agri-environmental programme designed for the plains of Arta and Preveza (Common Ministerial Decision 50981/2308) that have been characterised as Nitrate Vulnerable Zones. The proposed measures refer to changes in agricultural practices focusing mainly on reductions in the use of N/P fertilizers; setting aside irrigated land; crop rotation; and uncultivated strips or belts (buffer zones).

The above general measures were collaboratively discussed in terms of their scope, feasibility and effectiveness for specific cultivations in the Louros sub-catchments. Measures were specifically discussed in relevance to cultivations such as cotton, maize, citrus and clover. In contrast to our initial perception and plan, wheat was not included in those discussions, due to the fact that stakeholders argued that it is a rain-fed crop in this area of Greece. The ultimate goal was to end up with specific mitigation schemes, that is, combinations of measures that would potentially achieve compliance with WFD requirements under the base-line conditions and alternative climate change scenarios.

4.4.3 Perceived water quality problems

Workshop participants were aware of major issues and pollution sources in the aquatic environment of Louros. They agreed that nutrient enrichment is largely caused by agricultural practices applied in the sub-catchments of Arta and Preveza plains. Recognizing the excess use of fertilization as a critical source of nitrification, farmers participating in the workshop discussed and provided specific information on the usual application of basic and surface fertilization and the associated yields for the major cultivations in the Louros sub-catchments.

A first discussion concerned cultivations contributing most to nitrate and phosphate pollution and showed that four arable cultivations, i.e., maize, wheat, cotton, and medic (alfalfa) comprise more than 95% of all arable land in both sub-catchments. Furthermore, two perennial crops, i.e., citrus tree plantations and olive groves, comprise again more than 90% of all tree plantations in the two sub-catchments, the rest cultivated by kiwi fruit plantations and other fruit trees. It was unanimously recognised that wheat cultivation in the Arta-Preveza plain is not fertilized and is not irrigated and is a rain-fed crop. All participants also argued that the proportion of olive trees

under intense cultivation including slight fertilization and irrigation is very restricted in this area of Greece. Thus, it was agreed that the focus of the discussion should be on the cultivations of maize, cotton, medic and citrus tree plantations.

4.4.4 Identified solutions

Discussion focused on existing environmental legislation and policy measures, and more particularly on the action programme intended to deal with the nitrification problem in the Arta-Preveza plains. Stakeholders approved the existing plan expressing, though, rather marginal criticism on specific aspects and measures. Subsequently, the Patras research team presented crop-specific "usual" (recommended) fertilizer application in the area (drawing from the nitrification programme), while stakeholders (especially farmers) indicated real application, which differs somewhat and is sometimes lower and sometimes higher than "usual". Then, the timing of fertilization (input to WP5) was discussed and the research team tried to obtain information on average applications, as fertilizers applied are different in terms of their N and P content, according to soil requirements. The, water requirements and the timing of irrigation (inputs to WP5) were discussed; it was found that timing was compatible with agronomic requirements and that many farmers have decreased irrigation to avoid paying fees to TOEBs or reduce energy costs for irrigation. From the discussion it was evident that P fertilization is connected to N fertilization as farmers try to apply both fertilizers in one application and avoid doubling the cost of fertilizer application. Thus, any attempt to reduce N fertilization will also reduce P fertilization.

Then, the discussion centered on the investigation of two issues, namely, relationships between N/P and yields specific to all mitigation levels, and; the effect of alternative mitigation measures associated with crop rotation. The latter involved two issues; first, if alternative crop rotations lead to the need for less fertilization next year and second, impacts on N fertilization (for next year) specific to alternative rotations.

Subsequently, alternative measures (and their combinations) for cotton, maize, citrus and clover were discussed in terms of their feasibility and effectiveness with respect to reductions in nitrogen and phosphorous loads. Measures such as setting aside of 35% of irrigated land were characterized as extreme and were unanimously rejected. Other proposed measures such as crop rotation with nitrogen-trapping legumes were faced with considerable caution, especially in terms of their effectiveness. Also, as citrus cannot be associated with rotation, alternatives such as buffer strips and the reduction of N fertilizers were discussed. For example, an alternative measure for citrus tree plantations would be to manage the understory with either nitrogen trapping legumes or by applying minimum tillage. Farmers argued that in this part of Greece such a measure would be impossible, as the majority of citrus plantations are irrigated by systems of drip irrigation, also used as anti-frost devices during winter. Thus, the channel of irrigation pipelines is permanent on the ground and no ploughing would be possible.

For all mitigation measures, information was obtained on their nitrogen loading effect (per ha) and cross-checked with relevant agronomic studies estimates. The discussion of combinations of measures led to the specification of alternative mitigation schemes specific to maize, cotton, citrus and clover. These measures are:

Mitigation measures discussed and approved for cotton, maize and clover

- Set aside 25% of irrigated land, reduce N fertilizers (including manure) by 25% to the rest of the 75% of irrigated land;
- Crop rotation with non-irrigated nitrogen-trapping legumes on 20% of irrigated area; no fertilization to the 20% of land which was rotated with nitrogen-trapping legumes during the previous year for cotton and half of the fertilization for maize; leave 5% of land (strips or belts) uncultivated; reduce N fertilizer (including manure) by 25% to the rest of the 55% of irrigated land;
- Set aside 30% of irrigated land, reduce N fertilizers (including manure) by 30% to the rest of the 70% of irrigated land;
- Crop rotation with non-irrigated nitrogen-trapping legumes on 25% of irrigated area, no fertilization to the 25% of land that was rotated with nitrogen-trapping legumes during the previous year for cotton and half of the fertilization for maize, leave 5% of land (strips or belts) uncultivated, reduce N fertilizer (including manure) by 30% to the rest of the 45% of irrigated land.

Mitigation measures discussed and approved for citrus

- Reduce N fertilizers (including manure) by 25% and 30% to the whole of the plantation.

4.4.5 Climate change considerations

Concerns associated with climate change were expressed about lower water level, decreased water supplies and sudden and extreme runoffs during summer time and before sowing the maize and cotton production. Farmers showed a clear understanding of the economic and financial consequences of climate change. For example, they were able to connect lower aquifer levels with increased energy costs for irrigation and the risk to increased water salinization at least in certain areas close to the wetlands. Extreme events lower yields with profound impacts on incomes, while unforeseen or unusual rains during summer demand extra plant protection activities, which increase the production cost. However, the implications of alternative climate change scenarios for the Louros sub-catchments proved a difficult issue to grasp for the majority of stakeholders. This was due to the fact that, for certain crops and certain scenarios, the yield is forecasted to increase while for other crops but under the same scenario, the yield is forecasted to decrease. Hence, scenarios and story lines specified for the Louros catchment area (Skuras, 2011) drawing from the relevant Bank of Greece study were presented and discussed. In general, stakeholders approved the scenario-specific elements and agreed with their contents and projections.

4.5 Norway

The stakeholder workshop was held at a guest-house on the shores of Lake Vansjø on March 2nd 2011. The main purpose of the workshop was to discuss a possible mitigation measure that is linked to the operation of the dam at the outlet of the lake. Main issues concerned flooding problems for some stakeholders (e.g. farmers, land owners), and the risk of too low water levels

for others (hydropower, industry, boat owners, etc.). The main problem area concerns the sub-catchments of the lake (i.e. the eastern and western basins of Lake Vansjø).

4.5.1 Stakeholders' recruitment

The stakeholders represented several institutions, including representatives from the hydropower company, the water consuming industry, the drinking water supply plant, the farmers' association, the land owner associations, several NGOs (the hunting and fishing society, the boat club, local units of the Norwegian Trekking Association), representatives from regulatory bodies (several municipalities, the County governor, the River Basin District Organization, the River Basin Authority and the Norwegian Water Resources and Energy Administration).

4.5.2 Methods used

An important part of the methodology was thorough preparations, including stakeholder identification and sending out information to the stakeholders. At the workshop, a combination of plenary and break-out group sessions was held. In the first plenary session, both the problem (water quality) and suggested mitigation measures (see below), were presented by researchers. The groups then discussed different options for solutions and each user-group was allowed to express its needs and requirements. An important workshop rule was laid down beforehand, i.e. that no one could criticize any of the other participants' views.

The groups were divided into (a) hydropower and water demanding industry; (b) environmental concerns; (c) farmers' needs; and (d) boating, tourism and leisure. In the final plenary session the groups presented their work and a short discussion followed. A report was then made and circulated, and a hearing meeting was held in August 2011.

4.5.3 Perceived water quality problems

The main pressure of the Vansjø-Hobøl Catchment is an overloading of nutrients. This has resulted in severe blooms of toxic blue-green algae, especially in the years following a major flood in 2000. The lake is dammed near the sea, and the narrow strait leading down to the dam is a bottleneck when the catchment is flooded.

The main reason for the nutrient pressures is believed to be runoff from agricultural fields and untreated sewage. In addition, the soils in this area are naturally rich in apatite-phosphorus. This means that increased erosion will affect the nutrient loadings of this catchment. Flooding is an additional problem, since this will lead to increased nutrient inputs to the lake, both from riverine erosion, flooded fields and flooded sewage treatment plants.

4.5.4 Identified solutions

In the Vansjø-Hobøl (Morsa) catchment, several mitigation measures have already been agreed upon and set into operation. These include agricultural measures to reduce soil and nutrient losses, as well as measures to reduce sewage from scattered dwellings. Since many of these measures have not only been discussed with stakeholders for many years, but also been implemented for a decade, representatives from the regulatory bodies expressed that it was not desirable to revisit old discussions. Thus, the mitigation measure discussed in this workshop is therefore one of a limited set of remaining mitigation options in the catchment, and concerns a change in the operation scheme of the dam at the outlet of the lake. Lake Vansjø is dammed at Moss, close to the catchment's outlet in the Oslo Fjord, and the waterfall is utilised for hydropower production. The two main options are:

1. to keep water levels as high as possible during summertime in order to dilute the nutrients as much as possible (this is the rationale of the existing operation scheme); or
2 to ensure enough water early in the summer in order to maintain a flow of water through the dam at Moss.

This measure will have impacts not only on environmental issues but also on different stakeholder groups.

Based on the views from the different user groups at the workshop, a new suggestion for an operation scheme was made, which basically follows option # 2, above. At a hearing meeting in August, the users were in general positive to the outcome of the workshop, and some also expressed that the workshop had given them valuable insight into the needs of other user groups. It seems, therefore, that the workshop contributed to an improved understanding of the many different needs of the stakeholders in the catchment.

4.5.5 Climate change considerations

Climate change was raised as an issue since changes in precipitation pattern is likely to increase the risk for floods in certain seasons. A change in the operation scheme may to some extent improve this, and in addition to the abovementioned suggested changes during summertime, lower water levels during winter were incorporated in the alternative scheme. In addition, the stakeholders discussed the possibility of building a flood canal from the lake to the sea in order to reduce the risk for floods. This is a major construction and will need a thorough impact assessment.

4.6 Scotland

A stakeholder workshop was held in Dunecht, North-east Scotland, on February 3rd 2012. The aim of the workshop was to explore the views of local stakeholders on measures to alleviate water quality problems in the Leuchar Burn and Loch of Skene, in the North-Eastern part of the Dee catchment.

4.6.1 Stakeholders' recruitment

Twelve attendants representing three main groups of stakeholders were present. These comprised (1) a *farmers* group, including tenants and landowners; (2) representatives of *other land users/managers*, including Estate, forestry and quarry representatives; and (3) an *environment* group, which includes the environment protection and conservation agencies, environmental NGOs and representatives of the Dee Catchment Partnership.

All major land using activities in the sub-catchment were thus represented, as were the key regulatory bodies. However, although a number of water quality issues were attributed to households (septic tank discharges), this group was not formally represented in the discussions. However, a number of those attending lived in the sub-catchment and had homes with septic tanks, which meant that observations made were grounded in personal experience.

This workshop builds on the long-term engagement between the James Hutton Institute (JHI), in collaboration with the Scottish Government, and stakeholders in the region developed as part of

an ongoing research programme. The organisation and planning of the workshop was facilitated by the involvement of the Dee Catchment Partnership.

4.6.2 Methods used

A combination of plenary and break out group sessions was held on three main issues: (1) discussion of water quality problems in the sub-catchment and the sources of these pressures, (2) discussion of measures to alleviate these problems and perceptions of their cost and effectiveness, and (3) discussion of climate change and its effect on water quality and adaptation measures.

Support material was used for the discussions, including a two dimensional diagram with a horizontal axis representing the effectiveness of measures (from large impacts to small impacts) and a vertical axis representing costs (from high costs to low costs and even (farm) gains). The discussion on climate change used a simplified narrative of the most likely climate change scenario for this area, to be used as a basis for discussion.

A feedback questionnaire was distributed at the end of the event and a leaflet summarizing the main outcomes of the workshop was distributed to the participants afterwards.

4.6.3 Perceived water quality problems

Participants agreed that the main pressures in the area involve: (i) excessive nutrients and algal blooms in the loch, (ii) poor water quality in streams caused by diffuse pollution and (iii) impediments to migratory salmonids. The discussion further considered the sources of these pressures. While generally agreeing with the sources presented by the workshop facilitators as identified in WP6 catchment characterization work, participants made a number of additions, regarding notably the recent and fast-growing housing developments and ground sealing in the area that was seen as increasing the amount of run-off with negative impacts on water quality. Besides forestry, other commercial pressures on water quality were highlighted, notably, sediment runoff from the quarry was signalled as a potential source of water pollution. The role of geese in polluting the loch was discussed. There was recognition that the geese numbers are increasing, but participants were not certain that geese are a real problem for the Loch of Skene. It was pointed out that agricultural sources have been frequently blamed for water quality issues in the sub-catchment, but other, perhaps more important, sources may exist, such as septic tanks.

4.6.4 Identified solutions

An analysis focusing on the major sources of pollution and perceived cost-effective solutions, whilst searching for discrepancies within and across stakeholder groups, searching for knowledge gaps, and highlighting measures perceived as cost-ineffective (high cost, low effectiveness) was undertaken.

The list of measures to improve water quality identified in WP6 was significantly enlarged for this particular area. From this list, the measures perceived to be most cost effective in this area were adopting nutrient management systems, improving septic tank management, reducing fertilizer and manure application, following best practice in forestry harvesting and buffer strips.

For a significant number of measures (such as limiting grazing periods and reducing stocking rate. improved management of commercial run-off, contour ploughing, alternative water treatments, removing sediment from the stream bed, creating riparian woodlands, improving field drainage and re-meandering) no clear message emerged on their perceived cost-effectiveness. The control of migratory birds was perceived as cost-ineffective and impractical by the Royal Society for the Protection of Birds and other ornithology interests. The implementation of measures relating to Nitrate Vulnerable Zone regulations and Good Agricultural and environmental Condition (GAEC) were perceived as cost-effective by farmers and some of the other land users, but the other stakeholders did not comment on these measures.

A key finding of this workshop is that farmers in the area experience significant financial constraints, and, as such, the scale and availability of subsidies are perceived (particularly by farmers) as being crucially important for determining cost-effective management of water. For example, farmers thought that several of the measures (such as limiting grazing periods, reducing stocking and removal of sediment from the stream bed) could become cost-effective only if supported by subsidies. This is consistent with the findings of the conceptual model and stakeholder analysis developed in WP1 (Deliverables 1.14 and 1.16), where finance was found to be one of the key barriers to uptake of measures by land managers. Deliverable 1.16 does not refer strictly to scale, but rather to geographical location and area of farming land, but in any case there is a clear spatial component that affects both the barriers to uptake and the perceived cost-effectiveness of measures. Other components of the conceptual model (e.g. time and labour) are less apparent regarding cost-effectiveness.

4.6.5 Climate change considerations

Those present were asked about the implications of climate change on the problems and solutions identified. They partly contested the climate change scenario that has been developed for the Dee in WP1 (Deliverable 1.6). Thinking about long-term climate change was challenging for many of those present, but participants were able to provide insightful and well-argued expectations about the effects of climate change on water quality and mitigation measures. A key finding is that climate change impacts on agriculture (and consequently on water quality) are seen as negligible compared to the effects of the CAP reform. Once again, this is consistent with the conceptual model developed in the project (Deliverables 1.14 and 1.16) in which external factors that affect capital (prices, markets) and other decisions that can affect the environment (such as CAP) play a major role. Actions to improve water quality in the face of climate change might therefore be more effective were they to address non-agricultural sources (e.g. commercial and housing).

5. Conclusions: common and divergent trends

The discussion of perceived water quality problems, which took place in the six workshops indicated several similarities and some divergences. Nutrient pollution is generally perceived as the the most common problem in all case studies, while agricultural activity and sewage treatment were also identified as the major sources of pollution. Naturally, identified problems

had often a contextual perspective, this including (in addition to the above-mentioned problems) diffuse pollution, point source pollution and physical modification in the Thame, flooding and occasional draught in Pyhäjärvi, flooding in Vansjø-Hobøl, diffuse pollution and impediments to migratory salmonids in the Dee. Also, in Pyhäjärvi (a good ecological status catchment), the issue was the risk of eutrophication. Sources of pollution diverging from common trends include fishery management of ponds (which is very specific to the carp ponds of the Czech Republic), housing development and private septic tanks (most important repercussions of urban development in the Thame area, but potentially also on the Dee sub-catchment), forestry, quarries, septic tanks and the increase in the number of wintering wild geese at the Dee.

Despite the similarities observed as far as water quality problems are concerned, divergences in contextual factors and subsequent differences in the feasibility, scope and perceived effectiveness of mitigation action, all led to the specification of a significant variety of solutions. Indicatively, in the Czech Republic, workshop participants raised the importance of enforcing existing regulation (something that also applies in the case of Greece), while they argued in favour of agri-environmental measures, the construction of wastewater treatment plants and secondarily, of the reduction in the size of herds and banning of free winter-breeding. The need for introducing more flexibility (in terms of adjusting its means according to regional needs and characteristics) in the regulation on water quality was emphasized in the Thame workshop. Measures perceived as cost-effective include the decrease in pesticide use, crop rotation, flexible field margins, improved septic tank management and (from a softer perspective) awareness-raising for land managers and farmers in pollution avoidance. Context-specific action was also favored by the Finnish workshop participants, who argued that measures should be targeted to locations where they are most effective. Participants in the Lake Pyhäjärvi workshop seemed to pay significant attention to strategic policy issues (perhaps because of the composition of those attending) and argued for the need of a stronger focus on water management and soil structure as well as developing organic farming. In terms of measures suggested, these include controlled field drainage, prevention of soil compaction, distinct assistance for organic farming (which could facilitate an environmentally-friendly farming industry) and the use of fishing as an effective lake restoration method. The lack of a clear strategic policy focus and the non-application of the local nitrification action plan seemed to be the important issues characterizing the Louros water quality problems. As farming (and more specifically, cotton, maize, clover and citrus cultivation) was identified as the major contributor to non-compliance, the workshop specified several mitigation measures, which have the potential to reduce nitrogen-loading effects. In the case of the Vansjø-Hobøl workshop, several mitigation measures (including agricultural measures aiming to reduce soil and nutrient losses and measures to reduce sewage from scattered dwellings) have already been implemented and were not discussed. Instead, the focus of discussions was on measures aiming to ensure enough water early in the summer in order to maintain water flow through the Moss damn. Finally, participants in the Dee workshop identified a wide range of mitigation measures and argued in favor of adopting nutrient management systems, improving septic tank management, reducing fertilizer and manure application, and following best practice in forestry harvesting and buffer strips. Also, the measures associated with Nitrate Vulnerable Zones and Good Agricultural and Environmental Conditions (GAEC), were perceived as a cost-effective option by farmers and

other land users. However, it is worth mentioning that farmers argued that even currently compulsory measures (e.g. GAEC) would become cost-effective if supported by subsidies.

Workshop participants were (in all cases) able to develop a consensus on the potential effects of climate change. They perceived changes in terms of increasing temperature and precipitation, nutrient loading patterns, decreasing water availability and increasing the likelihood of extreme events. They also argued that climate change would affect agriculture, habitats and human/animal health, as well as the effectiveness of (currently implemented and proposed) mitigation measures. On the other hand (with very few and rather marginal exceptions, such as Norway and perhaps, Finland), stakeholders seem to have a rather contemporary perception of conditions and cannot project solutions in the form of "climate change proof" mitigation measures. Also, it is worth noting that in some cases, other issues (such as future developments in agricultural policy in Scotland, and wider rural/regional development in Greece) were perceived as being more important compared to climate change. This finding surely indicates the need for more coherent and rigorous efforts by policy makers (as all levels, i.e. international, national, regional, local) to raise awareness and initiate the detailed investigation of climate change response options.

Lessons learned on stakeholder engagement in a participatory assessment of possible adaptation strategies include the importance of factors such as the facilitation of open and well-structured discussions, satisfactory knowledge of catchment-specific water quality problems on behalf of research teams, interaction between workshop participants, which have different interests (i.e. different groups), and careful composition of stakeholder groups. If those factors are well developed, they can lead to significant input by stakeholders on both catchment-specific pressures (including their sources), but mostly on potential adaptation measures, their perceived cost-effectiveness and the reasons which are important for determining measure-specific cost-effectiveness. Hence, stakeholder participation and input can considerably enhance policy design and efficacy.

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