GENESIS project: Synthesis and Policy Recommendations

Spray, Christopher; Allan, Andrew; Pulido-Velazquez, Manuel; Kupfersberger, Hans; Balderacchi, Matteo; Trevisan, Marco

Publication date:
2014

Document Version
Publisher's PDF, also known as Version of record

GENESIS
groundwater and dependent ecosystems

SYNTHESIS AND POLICY RECOMMENDATIONS

Deliverable D6.5: GENESIS, Work Package 6

SEVENTH FRAMEWORK PROGRAMME

GENESIS
groundwater and dependent ecosystems

Deliverable summary

Project title	Groundwater and Dependent Ecosystems: New Scientific and Technological Basis for Assessing Climate Change and Land-use Impacts on Groundwater		
Acronym	GENESIS	Contract number	226536
Date due			Month 12 in GENESIS
Final version submitted to EC			Month 18 in GENESIS
Complete references			
Contact person	Chris Spray / Andrew Allan		
Contact information	Centre for Water Law, Policy and Science, University of Dundee		
Authors and their affiliation	Chris Spray / Andrew Allan (UNIVDUN), Manuel Pulido-Velazquez (UPVLC); Hans Kupfersberger(JR); Matteo Balderacchi and Marco Trevisan (UCSC); Bjorn Klove (UOULU); Przemyslaw Wachniew (AGH)		
Project homepage	www.thegenesisproject.eu		
Confidentiality	A shorter version of the deliverable will be submitted for publication to xx - to be decided xxx- . The publication is confidential until it has been published. The deliverable can be used in WG C and other EC working groups.		
Key words	.		

GENESIS
groundwater and dependent ecosystems

List of GENESIS partners

Norwegian Institute for Agricultural and Environmental Research (CO)	Bioforsk	Norway
University of Oulu	UOULU	Finland
Joanneum Research Forschungsgesellschaft mbH	JR	Austria
Swiss Federal Institute of Technology Zurich	ETH	Switzerland
Luleå University of Technology	LUT	Sweden
University of Bucharest	UB	Romania
GIS-Geoindustry, s.r.o.	GIS	Czech Republic
French National institute for Agricultural research	INRA	France
Alterra - Wageningen University and Research Centre	Alterra	The Netherlands
Helmholtz München Gesundheit Umwelt	HMGU	Germany
Swiss Federal Institute of Aquatic Science and Technology	EAWAG	Switzerland
University of Science and Technology	AGH	Poland
Università Cattolica del Sacro Cuore	UCSC	Italy
Integrated Global Ecosystem Management Research and Consulting Co.	IGEM	Turkey
Technical University of Valencia	UPVLC	Spain
Democritus University of Thrace	DUTh	Greece
Cracow University of Technology	CUT	Poland
University of Neuchâtel	UNINE	Switzerland
University of Ferrara	UNIFE	Italy
Athens University of Economics and Business- Research Centre	AUEB-RC	Greece
University of Dundee	UNIVDUN	United Kingdom
University of Zagreb - Faculty of Mining, Geology and Petroleum Engineering	UNIZG-RGNF	Croatia
Helmholtz Centre for Environmental Research	UFZ	Germany
Swedish Meteorological and Hydrological Institute	SMHI	Sweden
University of Manchester	UNIMAN	United Kingdom
Alma Mater Studiorum Università di Bologna	UNIBO	Italy
Christian-Albrechts-University of Kiel	UNIKIEL	Germany

Table of contents

I. INTRODUCTION

I.1. Project and report Aims

The GENESIS project set out, principally, to review and develop scientific knowledge regarding groundwater systems, and to develop tools for better integrated management of these systems with related aquatic and terrestrial groundwater dependent ecosystems. The objectives of the project over its five year duration also included development of indicator methods, and of integrated model simulations applied to a series of representative European groundwater systems that incorporate new components on climate, land-use and pollution input changes.

Special efforts have been made to link the project research to the ongoing process of implementing the Water Framework and Groundwater Directives (WFD and GWD respectively) – for example, examining the role of biogeochemical processes in pollutant degradation and the vulnerability of groundwater systems in the context of the GWD art.4(c) "appropriate investigation". In addition, new methods were to be developed for assessing cost-effectiveness and the economic impacts resulting from changes in groundwater management practices across a range of the project case areas.

This report aims to set out the main conclusions from each of the constituent work packages under which work has been done for the project. It will then go on to detail those conclusions that have relevance to policy making at the EU level, and those that are most relevant to decision makers at the Member State level as they seek to implement the WFD and GWD. Work Packages 1 and 7 have been excluded from this report as they were not concerned with substantive research work.

I.2. Determining Policy-relevance

The outputs of a large and multi-disciplinary project like GENESIS contain a mixture of findings that are relevant for science, policy and a mixture of both. This report is focused primarily on those that fall into the latter two of these categories. The report concentrates on those findings that are related to:

- EU policies regarding the management of groundwater and the protection of groundwater dependent ecosystems;
- The effectiveness of the implementation of these policies, and of the instruments and techniques used to put these into practice;
- The effective implementation of the Water Framework (WFD) and Groundwater Directives (GWD);
- National policies and implementation strategies for effective transposition of the WFD and GWD.

II. POLICY-RELEVANT CONCLUSIONS FROM GENESIS NATURAL SCIENCE

II.1. Work Package 2: Groundwater Flow Characteristics

Objectives/Aims:

To implement tracer methodologies and numerical modelling as operational tools in characterisation of groundwater flow in the context of Ground Water Directive requirements.

Deliverables:

- Workshop on flow characterisation – looking at use of environmental tracer methodologies and numerical modelling to assess dynamics and timescales of groundwater flow.
- Produce a set of Guidelines on flowpath characterisation, dynamics and groundwater renewal - combining use of environmental tracers with numerical modelling to enable quantitative assessment of groundwater flow dynamics and patterns. *Revision and recommendations on methods for GWD and CIS.*
- Critical review of methods for assessment of vulnerability of groundwater systems.

Main Conclusions:

- Tracer methods have proven their usefulness in groundwater assessment and management, yet they are not always sufficiently recognized by groundwater managers, policy makers and stakeholders as an indispensable tool
- Tracer tools can be used to supplement conventional methods of hydrogeological field investigations and to develop conceptual models.

- Tracer data can improve numerical models used in groundwater management and integrate information on flows and source apportionment across a range of scales
- Tracer tools are useful in assessing vulnerability and time lags in the responses of groundwater and related ecosystems to overexploitation and pollution
- Tracer techniques are developing fast. They are becoming more capable of direct use in the field, increasingly rapid, assessable and specialised.

Main Policy Recommendations for consideration in relation to the Groundwater Directive, Water Framework Directive and Common Implementation Strategy:

Whilst the use of tracer tools is not explicitly requested by the European Water Framework Directive (WFD) or Groundwater Directive (GWD), setting the threshold values for pollutants and assessing groundwater status, pollution trends and risks all imply the use of various methods for thorough understanding of groundwater bodies. Use of tracer tools for groundwater age determination is however mentioned in this context in the Common Implementation Strategy Guidance Document No. 26 that supplements the WFD.

- The GWD, but also the WFD and the related CIS Guidance Documents should explicitly indicate tracer techniques as tools for understanding of groundwater systems.
- The CIS GD No. 18 should recognize the importance of tracers in temporal characterization of groundwater systems
- The CIS GD No. 26 should list tracer techniques in a comprehensive way in chapter 4.1 among methods used for the development of conceptual models.

Main Policy Recommendations for consideration at a National level:

The main recommendations reflect those at the EU level, with the emphasis on recognition at the member state level of the proven utility of tracers for assessment and management of groundwater dependent ecosystems. In particular:

- Tracers can be used to help assess the ‘“status” of groundwater bodies and groundwater dependent ecosystems, as required under WFD
- The use of Tracers can be an effective methodology for determining the pressures impacting on groundwater bodies and groundwater dependent ecosystems
- Tracers can be used to help develop effective and targeted programmes of measures under WFD to restore failing groundwater bodies. In particular, they can assist in determining source apportionment and flow processes that need to be considered in the development of restoration and remedial programmes. Tracers also help in quantification of time lags in the responses of groundwater and GDEs to restoration measures.

Tracers are, of course only one methodology and their use needs to be integrated with that of other bio-physical, socioeconomic and conceptual models, but there is scope to recommend their use as a core part of the process for groundwater protection and enhancement.

II.2. Work Package 3: Pollution input and leaching to groundwater aquifers

Objectives/Aims:

To quantify how pollutants enter groundwater and how biochemical processes affect the leaching and distribution of pollutants, attenuation of pollution and transport reactions and processes through the groundwater system from the source of input (diffuse or point).

Deliverables:

- Set of rules to perform diagnostics of pollutants and background loads in the soil system and to characterise and quantify sources and pathways of contamination. This to include validation, sensitivity and uncertainty in each case study. *Review of methods in CIS for future GWD*.
- Set of tools and assessment methods to detect pollutant leaching to groundwater at different scales and knowledge of biochemical processes in leaching assessment methods. *Assessment of present regulations and procedures*
- Report on sustainable measures to decrease point and diffuse pollution
- Impact of future scenarios considering climate change and land-use changes

Main Conclusions:

- Anthropogenic activities are drivers of groundwater contamination. The sources (diffuse and point) and pathways of groundwater contamination are related to the different pressures from a wide variety of activities
- Agriculture is the main driver of pesticide pollution from diffuse and point sources. Although plant protection products are regulated in Europe under Regulation (EC) No 1107/2009, there is an increasing concern about the pollution of ground and surface water caused by point sources of pesticides

- Tools are available for assessment at different spatial scales - for field scale: PEARL, PRZM, MACRO; for regional scale: GeoPEARL and FITOMARCHE; and for Pan European scale: EuroPearl. These methods were tested at Grue field site in Norway to include winter processes (i.e. all relevant hydrological processes) and the results how that snow melt-induced recharge (the main recharge event in cold climates) is not well simulated.
- Measures to protect groundwater bodies from point source at farm scale include basins and biobeds for pesticide wash water storage and treatment as well as swales, buffer strips and wetlands to store and clean farmyard runoff
- Measures to protect groundwater bodies from diffuse sources include: changes in the regulations (restriction of use, application rates, application window, protection of vulnerable areas); change of management practices (irrigation, best management practices for pesticide application, soil management, cover-cropping, crop rotation change to reduce the pressure of pests); economic instruments (e.g. fertilizer taxes), and use of buffer zones
- Nitrogen contamination is increasing in several areas. Agriculture and households are main drivers, diffuse pressure mainly from fertiliser use and sewage leaks.
- Several tools for assessment of nitrate leaching are used within the EU. GENESIS tested state-of-the-art models for field and regional scale assessment (ARMOSA, COUP, DAISY, EPIC, SIMWASER/STOTRASIM, SWAP/ANIMO) and compare their performance in a common test site with a highly vulnerable soil in Wagna (Austria). Some models performed poorly in the calibration phase but showed better results during validation, and vice versa.

Main Policy Recommendations for consideration in relation to the Groundwater Directive, Water Framework Directive and Common Implementation Strategy:

Legal setting - In Europe pesticide regulation is enacted through several different legislations - WFD, WD, SUD, 91/414. Nitrate legislation in Europe is also enacted through several different legislation

- ***Policy mechanisms for protecting groundwaters and controlling nitrate pollution should not just focus on regulatory methods***
- ***Policies should combine measures to protect*** groundwater bodies from diffuse sources including: - changes in the regulations (restriction of use, application rates, application window, protection of vulnerable areas); - change of management practices (irrigation, best management practices for pesticide application, soil management, cover-cropping, crop rotation change to reduce the pressure of pests); and - the use of buffer zones which may regulate the contact between surface and groundwater
- ***Policy should also focus strategies on reduction of the use of pesticides*** in agriculture (fertilization, irrigation, economic support) and
- and ***the design of more sustainable cropping systems*** based on IPM (low input farming, organic waste recycling, crop rotation).
- ***Policy mechanisms should also include economic instruments:***
  - taxes and subsidies can be applied directly to the polluting emissions through ‘‘effluent” taxes or based on emission proxies like polluting inputs ‘‘influent taxes” or subsidies.

Main Policy Recommendations for consideration at a National level:

In Europe point contamination and preliminary risk evaluation is regulated by legislation at national level (e.g. In Italy - Legislative Decree 152/2006)

- Member states should develop comprehensive, multi-layered adaption strategies to avoid/reduce pollution
- Conceptual models should be utilised to help plan a monitoring programme, based on simulation and forecasting models of different simulated scenarios
- Greater use should be made of new assessment tool and models to help identify the sources, the pathways of contamination and the potential for natural attenuation

II.3. Work Package 4: Groundwater dependent ecosystems: groundwater-surface water interaction

Objectives/Aims:

To understand how groundwater flow and water quality affect groundwater dependent ecosystems and to develop tools and methods to better assess vulnerability of groundwater dependent ecosystems to anthropomorphic changes.

Deliverables:

- Baseline study of groundwater dependent ecosystem hydrology – from case studies and existing knowledge
- Development of new hydrological processes model to explain how groundwater dependent ecosystems depend on groundwater delivery, and how this interaction occurs
- Develop new indicators for assessing groundwater dependent ecosystem vulnerability. *Recommendations for criteria for setting Groundwater Ecosystem Protection Areas for input to GWD*
- Report on protection of groundwater dependent ecosystems. *Recommendations for update of GWD on issues regarding protection of groundwater dependent ecosystems*
- Report on Impacts and Risks to groundwater dependent ecosystems of the changes in groundwater quality and quantity caused by changes in Land-use and Climate change.

Main Conclusions:

- Many GDEs are adversely affected by direct human impact, such as water abstraction and pollution, and other pressures such as land-use and climate change. Many European aquifers groundwater levels have decreased, with a potentially large influence on GDEs.

Special attention should be paid to the role of climate variability and change on spatial and temporal distribution of recharge, discharge and temperatures in GDEs.

- The effect of groundwater depletion and contamination depends on the local hydro-geological setting and climate. The combined impacts of water loss, nutrient levels, pesticides and other potentially toxic compounds are not well understood
- There are several ways to assess impact caused by human actions on ecosystems. This can be achieved by comparing biological communities in pristine (or nearly so) 'reference' sites with those in impacted sites. The comparison can be based on, for example: - species number; - ecosystem dynamics (primary productivity and decomposition); or - species traits and characteristics
- Conceptual and numerical models can be useful for predicting future changes in ecosystems, but the response in these systems is not well understood. Research on important GDEs should continue and the policy developed according to new scientific input.
- Many GDEs provide services with socio-economic values that have been undervalued, and should be considered and protected.
- The integration of natural and social sciences can contribute to a better holistic management of GDE.

Main Policy Recommendations for consideration in relation to the Groundwater Directive, Water Framework Directive and Common Implementation Strategy:

Legal setting - Ecological quality objectives for surface and ground water management are outlined in the Water Framework and associated Groundwater Directives. Precise Objectives and Approaches for the management of groundwater dependent ecosystems are not defined in detail in these directives (partly because of lack of knowledge).

Some GDEs include IUCN red-listed species, and key species of GDEs are protected through the Natura 2000 network. However although the habitats protected under Natura 2000 may coincide

with GDEs, the Natura 2000 system does not provide value to the role of the water system itself, undermining coordination between the frameworks established under the Habitats and Water Framework Directives

- Groundwater, surface water and GDEs should be considered and monitored in an integrated way. Particular policy focus should be on better integration of WFD, GWD and the Habitats Directive in this respect
- GDEs should be set also in a socio-economic context, considering both biodiversity conservation and ecosystem services
- Monitoring should be coupled with current groundwater and surface-water observation sites at a European level. This provides an option for backtracking past hydrological variations in GDEs and recognising major geographical differences
- Impact assessments should consider pressure on groundwater and GDE, their interactions and resilience, and socio-economical values of GDEs and aquifers.

Main Policy Recommendations for consideration at a National level:

- Sustainable land-use planning should recognise and avoid what are often considerable impacts on GDEs - by development and agricultural intensification
- GDEs should be included in national monitoring networks
- Monitoring sites should provide information on GDEs, hydrogeology (aquifers), and climate representative of the specific regions.

II.4. Work Package 5: Integrated Modelling of Groundwater Systems

Objectives/Aims:

To integrate process knowledge into a complete understanding of the groundwater system as a whole and to model the impacts on groundwater and related ecosystems based on the defined scenarios and using input from various work packages.

Deliverables:

- Development of adapted coupled simulation methods and techniques, and corresponding codes, for new processes
- Conceptual model development with emphasis on integration of GDE needs and socioeconomic issues; elaboration of scenarios for impacts resulting from land use and, climate change, and first runs of simulation model on these scenarios
- Modelling guidelines for land-use and climate change effects; Establishment and Evaluation of a flow and transport model for each of the case studies, including calibration and uncertainty assessment
- Final Report with simulations of measures and the response of the groundwater system at each case study site under different climate and land use change scenarios. *Input to needs of GWD (article 4.3c) on the risks of contamination from the impacts of biogeochemical processes on groundwater body and groundwater dependent* ecosystems.

Main Conclusions:

(a) Methodologies

- Numerical simulation models provide the most effective way to estimate the impacts of climate and land use changes on water quantity and quality of groundwater systems. In order to assess the impacts of the assumed future conditions (climate, land use, water demands, adaptation, etc.) on groundwater systems, some forms of coupling needs to be assumed between those forcings and hydrogeology. The coupling of numerical sub-models to groundwater models continues to be a challenge. Conceptual models or frameworks can be used as an alternative to illustrate the factors that need to be considered in integrated modeling that links climate to hydrology.
- Sequential coupling modelling techniques are powerful approaches to combine surface and groundwater processes, especially when processes are required to be modelled in detail, such as nitrate leaching, mass transport, land use and soil management. Integrated models are able to reproduce several hydrologic processes in GDEs.
- The modelling approaches used potentially lend themselves easily to scenario analysis, climate change analysis, cross-boundary flow analysis, and other management analysis at different spatial levels
-

(b) Results

- The relevance of climate and land use change impacts on groundwater and groundwater dependent ecosystems is not similar in all the case studies. The effects will be intensified if water abstraction is increased to meet a growing demand for water.
- In several case studies the relevance of changes in land management within current land uses has been found to be higher than the one caused by climate changes.
- Despite the uniqueness of the case studies, in all of them the potential effects caused by climate change in current land uses have potentially higher relevance than land use changes - due to changes in water requirements and/or changes in land use management strategies.

Main Policy Recommendations for consideration in relation to the Groundwater Directive, Water Framework Directive and Common Implementation Strategy:

- Predicting the behaviour of recharge and discharge conditions under future climatic and land use changes is essential for integrated water management and adaptation
- Policy direction should recognise that the main driving forces for changes to groundwater resources and groundwater dependent ecosystems are not the same across Europe. In Mediterranean areas climate change and pressure on land use appear as the main stressing factors, whereas in alpine and northern areas land use change influence seems to be higher. This is partly due to the fact that aquifers in the North are small in size, making them more sensitive to local land use changes. In cold climats, climate change will change snow accumulation and melt processes resulting in increased recharge in winter and lower baseflow in summer.
- Policy developments that focus on land use and land management can be powerful adaptation instruments to deal with climate change, especially in northern and alpine areas, where its influence has been found to be higher. Even in regions in which their impact is lower, they should be regarded as capable measures, given the high uncertainty levels associated with climate change and the fact that land use change can be well-controlled.
- Mediterranean areas in which groundwater problems have been reported are likely to be more stressed due to climate and land use change, requiring the re-assessment of the programs of measures already started or the definition of further measures
- In Alpine and Northern regions, the reported negative climate change effects on groundwater have been smaller as more recharge is predicted in winter months,. Land use management practices and longer crop cycles could impact groundwater quantity and quality and therefore continuous monitoring and integrated assessments are advisable. Increased use of pesticides in warmer climates can also influence vulnerable ecosystems.

Main Policy Recommendations for consideration at a National level:

- Member states should, as a matter of priority identify the main driving forces for changes to groundwater resources and groundwater dependent ecosystems – climatic or land use
- National bodies should develop a range of climate change and land use scenarios for each meteorologically and topographically distinct part of their country
- Policy direction should in the near and medium term focus on adaptation measures that can be delivered through changes to land use and land management
- National bodies should recognise the value of coupled models that can be used to design appropriate adaptation measures and to assess their effectiveness
- Member states should consider the potential need to re-assess their current programs of measures already started, and the definition of further measures in the light of the differences revealed in stresses due to climate and land use change in different parts of Europe.

III. POLICY-RELEVANT CONCLUSIONS FROM GENESIS SOCIAL SCIENCE AND LAW: GROUNDWATER SYSTEMS MANAGEMENT: SCENARIOS, RISK ASSESSMENT, COST-EFFICIENT MEASURES AND LEGAL ASPECTS

III.1. Work Package 6: Groundwater Management and Economics

Objectives/Aims:

The development of AN INTEGRATED FRAMEWORK of analysis for the selection of sustainable and cost-effective measures in the implementation of the Groundwater Directive (GWD) and Water Framework Directive (WFD).

Deliverables:

- Application of market and non-market valuation methods for the measurement of the total economic value of groundwater, to selected case study areas.
- Production of a publicly-available database of available groundwater economic valuation studies.
- Application of Bayesian Network and Hydro-economic modelling approaches for assessing and designing economically efficient instruments for groundwater management.

Main Conclusions:

- Hydroeconomic models (HEM), by integrating natural and socio-economic systems into a comprehensive analysis framework, can yield results that are more relevant for policy making than traditional groundwater management models. HEM can be used to estimate the cost of certain policies and their effectiveness in meeting the environmental objectives of the WFD. They can also assist in the design and assessment of effective economic instruments for certain targets or objectives or to meet certain requirements.
- There is no a single standard approach to deal with groundwater economic and management issues, but each case will require individual approaches tailored to the availability of data and market prices; the scope of the study and the policy questions being addressed; the physical setting; the economic drivers; the legal and institutional framework; and the amount of time, resources and expertise available for the study.
- The different methods provide complementary information: while the hydro-economic model suggests optimal groundwater management policies and potential impacts, the economic valuation techniques allow assessment of the benefits of improving the status of the groundwater system. Political instability can affect stakeholder willingness to pay for measures affecting water resources and their valuation of groundwater.

Main Policy Recommendations for the Groundwater Directive and Common Implementation Strategy:

- Groundwater is generally undervalued and underpriced, which leads in many cases to poor management practices that cause aquifer depletion and pollution. Quantifying its value is critical for determining what measures are appropriate for its remediation and improvement in status. Value estimates can play a major role in focusing policy-makers and public attention on threatened undervalued resources. Value estimates are also critical in order to evaluate the level of investment in groundwater development, protection, monitoring and management that can be economically justified. There is a broad array of economic and hydroeconomic techniques that can be applied for that purpose, as tested in the GENESIS project.

- Economic instruments, where used appropriately, can be effective tools for meeting some of the environmental objectives of the Directive.
- Publicly-available database of available groundwater economic valuation studies could be linked with CIS guidance on application of valuation techniques.
- Case studies provide lessons on the application of market and non-market valuation techniques for valuation of groundwater and the selection of cost-effective remedial measures.

III.2. Work Package 6: Law

Objectives/Aims:

- Qualitative holistic analysis of the existing regimes for control of abstraction rights (and their variability), along with control of pollution, especially from diffuse sources, to assess compatibility with the requirements of both the Water Framework (WFD) and Groundwater (GWD) Directives, and the degree to which implementation matches legal commitments.
- Assessment of the degree to which surface and ground waters are integrated at the institutional and management levels, and the capacity of institutions to achieve the pollutant threshold limits required by the GD especially in the context of the WFD characterisation exercise.

Deliverables:

- Analysis of legal and institutional implications of the implementation of the GWD.

- Application to selected case studies – Mancha Oriental and Rokua, with additional legal analysis in relation to the Vosvozis, and to the Zagreb, Czestochowa and Caretti case study areas.

Main Conclusions:

- Problems with implementation of the WFD/GWD are related both to quality of transposition and to institutional and technical infrastructure, and are similar across member states. Relevant factors that appear to apply across Member States include: the quality of monitoring networks, institutional fragmentation, and potentially the superimposition of WFD requirements on to existing water and land use management frameworks.
- Control of diffuse pollution and incorporation of ecological quality standards in water use management is proving to be difficult.
- There are questions regarding the general level of awareness of the EU legal context for environmental management.

Main Policy Recommendations for the Groundwater Directive and Common Implementation Strategy:

- Although the use of the disproportionate cost exemption under art.5(4) has been relatively under-utilised in the first round of river basin management planning, it is likely to increase in successive rounds. An imminent decision in the European Court of Justice regarding the meaning of the term' water services' for the purposes of the WFD will have major impacts on the importance of economic assessments, especially in states where irrigated agriculture is important.
- Adaptation measures in northern case study areas rely on changes in land use management and diffuse pollution control. While this is mandatory under the WFD, evidence from the GENESIS project case studies in Finland and Spain, along with

conclusions from the third WFD implementation report, suggest that this is one of the key areas where implementation is weak.

- Need for assessments of economic instruments / groundwater value to reflect standards that are legally binding on member states not just national realities.
- Diffuse pollution control and protection/improvement of ecological quality are generally poor. Especially critical in the north given important role of land use management as an adaptation measure in response to climate change.
- Legal case study evidence suggested that problems with transposition may be greater where WFD approach is overlaid on existing legal frameworks rather than where root/branch reform is undertaken.
- Approaches to management of diffuse pollution must take account of monitoring and enforcement capacity, but binding standards and improvement to monitoring networks should be strongly considered.

III.3. Work Package 6: Stakeholder Preferences

Objectives/Aims:

- To identify stakeholder preferences for the sustainable and cost-efficient management of groundwater using interactive decision-analysis framework.
- Identify areas of conflict between different groups of stakeholders using multi-attribute value theory.

Deliverables:

- Analysis of stakeholder participation and conflict resolutions through different approaches, such as multi-attribute utility theory.
- Refinement and application of MAVT approaches according to local circumstances in following case study areas:
    - Mancha Oriental;
    - Vosvozis; and
    - Rokua.

Main Conclusions:

- Use of Multi-attribute value theory can be a useful approach for eliciting stakeholder preferences to certain water resource management alternatives and pinpointing possible conflicts between them. Case study applications propagated negotiation and compromise, and also helped bridge the gap between scientific research and acceptable solutions.
- Selecting optimum alternatives across disparate groups of stakeholders is difficult. Because application of MAVT encourages stakeholders to identify their preferred solution individually, the scope for apparent conflict is high, despite the fact that ranking of the whole range of alternatives across varying groups is actually quite similar.
- Combinations of measures are likely to be more preferable rather than focusing on a single choice.
- Bayesian networks may be useful to assist stakeholders and decision makers in reaching agreement on the impacts of different policies on ecological and economic aspects of water use under uncertain conditions.

Main Policy Recommendations for the Groundwater Directive and Common Implementation Strategy:

- If groundwater management strategies are to be effectively implemented, there is a strong need to understand stakeholder preferences.
- The use of decision analysis techniques can be useful for identifying strategies that are acceptable to stakeholders at all levels, and for mediating conflicts between users.
- Application of MAVT approach highlighted that main conflicts are between stakeholders in general, and ecological protection. Suggests need for EU-wide efforts to secure greater buy-in for ecological status priority.
- Users of MAVT approach must interpret results carefully because application of MAVT encourages stakeholders to identify their preferred solution individually. The scope for apparent conflict is high, despite the fact that ranking of the whole range of alternatives across varying groups is actually quite similar. Participatory methods can be used to reduce conflicts.