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Farm System Management and Governance for Good Water Quality and Drinking Water Supplies

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# Protection of drinking water resources from agricultural pressures: effectiveness of EU regulations in the context of local realities

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# 2. SUMMARY

Over the last decades, nutrients and pesticides have proved to be a major source of pollution of drinking water resources in Europe. Extensive legislation has been developed by the EC to protect drinking water resources from agricultural pollution, but the achievement of water quality objectives is still an ongoing challenge throughout Europe.

The study aims to identify lessons that can be learnt about the coherence and consistency of the application of EU regulations, and their effects at the local level, using qualitative expert data for 13 local to regional governance arrangements in 11 different European countries. To this end, two aspects of implementation have been studied: the national implementation and the experiences in the local to regional governance arrangements of the FAIRWAY casestudies. Information on the national implementation is necessary to better understand the national context of the case studies. Therefore reference is made to 'countries' whenever it concerns national implementation. Furthermore it should be noted that the scale of the case studies differs, from local (e.g. a small island in Denmark) to regional (e.g. a transboundary catchment (Derg case study, Republic of Ireland – UK/Northern Ireland), related to the different focal points of the case studies (e.g. local well pollution (Denmark) versus regional optimization of fertiliser usages (Germany)). Therefore reference is made to 'local to regional case studies'.

The results show that the complexities and inconsistencies of European legislation drawn up to protect drinking water resources from agricultural pollution come forward most explicitly at the local level where cross-sectoral measures are implemented and effects monitored. This hampers local and regional efforts to achieve water quality objectives. The upcoming revision of the Water Framework Directive (WFD) creates an opportunity to strengthen the links between different directives and how they can be applied coherently and consistently at the local level.

In addition, a more facilitated cross-sectoral approach should be adopted to improve stakeholder networks, both between institutional levels and hydrological scales, to attain policy objectives at the local level.

This report provides the results of a study that has been carried out in work package 6.3 of the H2020 FAIRWAY project, funded by the European Union's Horizon 2020 research and innovation programme under grant agreement No 727984.

Work package 6 as a whole, aims to examine the coherence and consistency of EU directives and policies (WP6.1); to compare governance arrangements in a range of case studies (WP6.2); to identify lacks of coherence and possible spill-over effects from challenges at the EU level to national, regional and local levels (WP6.3); to identify cost-efficient and coherent management models (WP6.4); and to develop legitimate governance arrangements (WP6.5).

Report D6.1 (result from WP6.1) describes the coherence and consistency of EU directives and policies. Report D6.2 (result from WP6.2) provides an overview of the implementation of these EU directives and policies and governance arrangements in the 13 FAIRWAY case studies. The present report (D6.3) combines these materials and analyses coherence and consistency of implementation of EU regulations and their effects at the local and regional level. In line with the Grant Agreement of the H2020 FAIRWAY project, the results are presented as a scientific paper. This paper is published in the Journal of Environmental

Management[1]. This report D6.3 contains the paper, supplementary materials, and additional information on all case studies of FAIRWAY.

Report D6.4 on cost-effective management models (result from WP6.4) compares potentials and barriers of water quality protection by catch crops and other measures for efficient impementation across countries. All these four reports form the foundation for WP6.5 on the development of legitimate governance arrangements to prevent diffuse pollution of European fresh water due to agriculture, resulting in a policy brief.

[1] Susanne Wuijts, Jacqueline Claessens, Luke Farrow, Donnacha G. Doody, Susanne Klages, Chris Christophoridis, Rozalija Cvejić, Matjaž Glavan, Ingrid Nesheim, Froukje Platjouw, Isobel Wright, Jenny Rowbottom, Morten Graversgaard, Cors van den Brink, Inês Leitão, António Ferreira, Sandra Boekhold (2021). Protection of drinking water resources from agricultural pressures: Effectiveness of EU regulations in the context of local realities. Journal of Environmental Management, Volume 287, 2021, 112270, ISSN 0301-4797, https://doi.org/10.1016/j.jenvman.2021.112270.

# 3. PROTECTION OF DRINKING WATER RESOURCES FROM AGRICULTURAL PRESSURES: EFFECTIVENESS OF EU REGULATIONS IN THE CONTEXT OF LOCAL REALITIES


## ABSTRACT

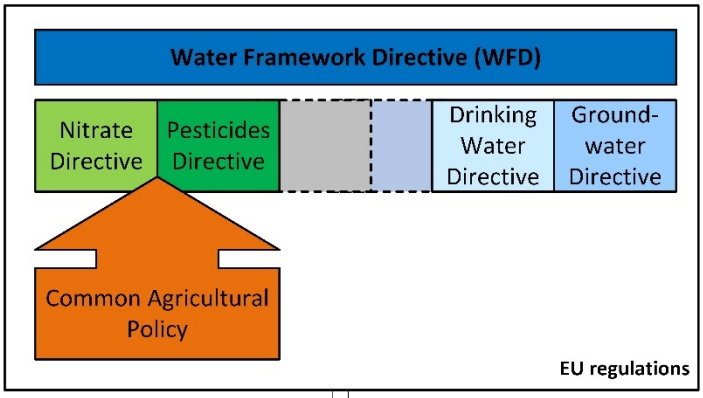
Over the last decades, nutrients and pesticides have proved to be a major source of the pollution of drinking water resources in Europe. Extensive legislation has been developed by the EU to protect drinking water resources from agricultural pollution, but the achievement of water quality objectives is still an ongoing challenge throughout Europe.

The study[1] aims to identify lessons that can be learnt about the coherence and consistency of the application of EU regulations, and their effects at the local level, using qualitative expert data for 13 local to regional governance arrangements in 11 different European countries.

The results show that the complexities and inconsistencies of European legislation drawn up to protect drinking water resources from agricultural pollution come forward most explicitly at local level where cross-sectoral measures have to be taken and effects monitored. At this local level, rather than facilitate, they hamper efforts to achieve water quality objectives. The upcoming revision of the Water Framework Directive (WFD) should strengthen the links between the different directives and how they could be applied at local level.

In addition, a more facilitated cross-sectoral approach should be adopted to improve stakeholder networks, between institutional levels and hydrological scales, to attain policy objectives at local level.

**Protection of drinking water resources from agricultural pressures: effectiveness of EU regulations in the context of local realities**




**Key messages:**

- Difficulties in achieving WFD ambitions;
- Complex EU legislation on agriculture and protection of drinking water resources;
- Implementation at national level could benefit from advanced cross-referencing;
- It all comes together at the local level: capacity needed for cross-sectoral decision making.


**Study design:**

- Analysis of governance approaches of 13 case studies in 11 European countries
- Using OECD principles for water governance

## 3.1 INTRODUCTION

Currently, nitrates and pesticides are among the major sources of drinking water resources pollution in Europe (EEA 2018). In order to reduce and mitigate emissions from agriculture to water and protect the environment, the EU has developed an extensive regulatory and policy framework that addresses both water and agricultural sectors, environmental pollution and land use over the last decades (Platjouw, Moore et al. 2019). In addition to these legal obligations, many other initiatives have been developed at local and regional scales to further contribute to the protection of drinking water resources (Doody, Foy et al. 2012, Graversgaard, Hedelin et al. 2018), some of which had already begun in the nineties (Quirin and Hoetmer 2019).

These initiatives were often triggered by an increased awareness that existing legal frameworks were insufficient to adequately protect drinking water resources from agricultural pollution (Keessen, Runhaar et al. 2011, Doody, Foy et al. 2012, Jacobsen, Anker et al. 2017). The directives had varying success in water quality improvement. The European Innovation Partnership on Water (EIP Water) identified the 'inconsistency and fragmentation of policies, regulations and governance structures' as 'low hanging fruit' whose improvement would greatly enhance the development of the sector (EC 2014). This article aims to contribute to the understanding how this 'inconsistency and fragmentation of policies, regulations and governance structures' impacts water quality improvement at the local level and what lessons can be learned from experiences so far. Governance is defined here as a process of interaction between public and/or private actors, ultimately aiming at the achievement of collective goals, including the knowledge, instruments and means to do so (Lange, Driessen et al. 2013).

The inconsistency noted by the EC (2014) can to some extent be explained by the development of European environmental legislation over time. At first, directives focused on the protection and restoration of water quality for specific water functions like drinking water (DWD, 75/440/EEC) and groundwater (80/68/EEC). During a second phase, directives focused on the reduction of emissions such as the Nitrates Directive (ND, 91/676/EEC), the Sustainable Use of Pesticides Directive (SUPD, 2009/128/EC) the Urban Wastewater Directive (UWWD, 98/15/EC) and the Integrated Pollution Prevention Control Directive (IPPC, 96/61/EC). In this phase, legislation addressed water quality issues from a sectoral point of view and less attention was paid to stakeholder involvement (Van Rijswick and Havekes 2012). A third phase in the development of European water quality law can be identified with the introduction of the Water Framework Directive (2000/60/EC), reflecting the growing awareness that complex water issues cannot be addressed by legislation alone and are specific to a river basin (OECD 2015, Howarth 2017). The WFD, with its river basin approach, requires new governance arrangements for cross-sectoral cooperation with other stakeholders, both within and between Member States.

The shift towards governance-based approaches can be seen in national policies as well, although differences exist between Member States (Rowbottom, Wright et al. 2019). Several scholars noted that the mode of implementation[2] is often adapted to existing national regulatory and policy structures, in accordance with the principle of subsidiarity, but research has shown that this mode of implementation may also impact its effectiveness (Keessen, Van Kempen et al. 2010, Giakoumis and Voulvoulis 2018, Birkenstock and Röder 2019).

[2] The term 'implementation' refers to an explicit phase in the policy process: the execution of interventions to achieve policy objectives. It also refers to the transposition of European legislation into national law. In this article the focus is on the attainment of policy objectives. To avoid confusion regarding the use of the term 'implementation', the term 'attainment' is used.

Even more, building on existing national regulatory and policy structures for the implementation of EU legislation may also be the cause of the inconsistencies and fragmentation of policies in the achievement of the European ambitions (Keessen, Van Kempen et al. 2010, Birkenstock and Röder 2019).Coherence and consistency are key factors if we are to have a successful EU regulatory and policy regime that aims to prevent, and manage, the diffuse pollution of drinking water resources caused by agriculture. At regional and local scales, it may become clear whether the coherence and consistency between these policy domains is addressed well enough to achieve policy objectives.

In this context, coherence is defined as the extent to which laws and policies systematically reduce conflicts and promote synergies between, and within, different policy areas to achieve jointly agreed policy objectives (Nillson, Zamparutti et al. 2012). A sectoral policy can be effective in achieving its specific objectives without being coherent in relation to the objectives of other policy areas (Platjouw, Moore et al. 2019). Consistency marks the extent to which the jointly-agreed policy objectives can be recognised at different levels, and within different policy arenas, and there is no contradiction between them.

Several publications address the importance of analysing the impact of governance on water quality outcomes (e.g. (Newig and Fritsch 2009, Blackstock, Waylen et al. 2012)). So far however, little empirical research has been done on the local governance arrangements that could contribute to better groundwater and surface water quality (Wuijts, Driessen et al. 2017); studies are often of an aggregated national or European level, for instance to evaluate the implementation of a particular Directive (EC 2018, EC 2019a).

This article aims to discuss from the local-regional perspective, (1) whether the different parts of EU legislation and their mode of implementation strengthen or block one another, (2) whether local governance arrangements can overcome potential gaps or spill-over effects in this legal framework and (3) what lessons can be learnt to improve the protection of drinking water resources from agricultural pressures. To this end, governance arrangements in 13 case study areas in 11 European countries were analysed, using the OECD principles on water governance (OECD 2015) as the analytical framework and tested on the criteria coherence, consistency and the attainment of objectives at the local level.

## 3.2 METHODOLOGY

### 3.2.1 Case studies

The effectiveness of EU legislation on the restoration of drinking water resources and their protection from agricultural pollution was examined using empirical research as carried out in the H2020-FAIRWAY-project (www.fairway-project.eu, last accessed January 12th, 2021). For 13 case study areas in Denmark, England, France, Germany, Greece, the Netherlands, Northern Ireland, Norway, Portugal, Romania and Slovenia, Multi Actor Platforms (MAPs) were installed or are under construction aiming to facilitate aspects of local-regional governance approaches (Sundnes, Van den Brink et al. 2020). These MAPs are a more-or-less ongoing mechanism for actors from different sectors and levels, including farmers, advisors, drinking water companies, scientists and policy makers, to meet regularly to foster the exchange of ideas and initiatives and promote joint decision-making and collaboration in a continuously evolving way (Acquaye-Baddoo 2010). The size of these case study areas varies as a consequence of both institutional settings and water system characteristics, ranging from a few hundred $km^2$ to tens of thousands of $km^2$ (local to regional scale). The 13 case study areas cover different types of drinking water resources, pedo-climatic zones, type

of farming, land use, legal framework, and governance approaches used, and offer a pan-European view of experiences with local governance arrangements for the protection of drinking water resources from agricultural pollution (Sundnes, Van den Brink et al. 2020). Table 2.1 presents an overview of the case studies used in our analysis. More detailed descriptions of the case studies can be found on https://www.fairway-project.eu/index.php/case-studies (last accessed January 12th, 2021).

In this article, three of these 13 case studies will be presented more extensively as they elucidate some of the key results of our analysis and demonstrate local experiences. These are the cases from Northern Ireland (Derg Catchment), Germany (Lower Saxony) and Greece (Axios River).

*Table 2.1 Overview of case studies.*

| Country | Name | Type of Resource for Drinking Water | Principal Water Quality Issue(s) | |
|---|---|---|---|---|
| | | | Nitrates | Pesticides |
| Denmark | Island Tunø | Groundwater | X | X |
| Denmark | Aalborg | Groundwater | X | X |
| England | Anglian Water | Surface water | | X |
| France | La Voulzie | Groundwater (springs) | X | X |
| Germany | Lower Saxony | Groundwater | X | |
| Greece | Axios river | Groundwater and surface water | X | X |
| Netherlands | Province of Overijssel | Groundwater | X | X |
| Netherlands | Province of Noord-Brabant | Groundwater | | X |
| Northern Ireland | Derg catchment | Surface water | | X |
| Norway | Vansjø | Surface water | X | |
| Portugal | Baixo Mondego | Ground and surface water | X | X |
| Romania | Giurgiu county | Groundwater | X | |
| Slovenia | Dravsko Polje | Groundwater | X | X |

### 3.2.2 Analytical framework

The literature contains many descriptions of frameworks for analysing conditions of water governance (e.g. (Pahl-Wostl, Lebel et al. 2012, Van Rijswick, Edelenbos et al. 2014, OECD

2015)) and although these frameworks encompass similar elements, they differ in terms of accents and scope (Wuijts, Driessen et al. 2017). For instance, the analytical framework drawn up for sustainable water governance (Van Rijswick, Edelenbos et al. 2014) has a diagnostic nature with an explicit focus on implementation and the attainment of objectives. The framework developed by Pahl-Wostl, Lebel et al. (2012) aims to compare and quantify the governance approaches used in different river basins. This scale, however, is too aggregated for the purpose of our study (local to regional scale). The investigation of local-regional governance arrangements for attainment of EU objectives, requires a framework that facilitates an analysis across scales, encompassing both the national implementation and the local to regional experiences with the attainment of objectives. For this reason, the OECD Water Governance Principles (2015) were used as a framework for our analysis.

The OECD principles are based on the general principles of good governance: legitimacy, transparency, accountability, human rights, rule of law and inclusiveness (OECD 2015). The framework contains three mutual reinforcing dimensions: Effectiveness, Efficiency and Trust and Engagement. Data has been collected for all twelve principles of the analytical framework. Since this article focuses on the criteria coherence, consistency and the attainment of objectives at local level, the results related to these criteria are described here (see Table 2.2). A full summary of data can be found in the supplementary material (Annex I and II).

*Table 2.2 OECD Water Governance Principles (OECD 2015) that are included in the analysis of the criteria consistency, coherence and, mode of implementation and the attainment of objectives at local level.*

| **Dimensions and Principles**<br>**Analytical framework (OECD, 2015)** | | **Criteria for analysis** | | |
|---|---|---|---|---|
| | | **Consistency of EU regulation** | **Coherence across sectors and levels** | **Attainment of objectives at local level** |
| **Effectiveness** | Capacity | X | | X |
| | Policy coherence | | X | X |
| | Appropriate scales within basin systems | X | X | X |
| | Clear roles and responsibilities | X | X | |
| **Efficiency** | Regulatory frameworks in place and enforced | | X | X |
| | Data and information | | | X |
| **Trust and Engagement** | Trade-offs across users, areas, and generations | | | X |
| | Stakeholder engagement | X | | |
| | Integrity and Transparency | | X | |

### 3.2.3 Questionnaires

The national implementation and the resulting local-regional governance arrangements in the case studies served as the unit of our analysis; an analysis which was carried out in four consecutive steps.

Firstly, the four principles related to the Effectiveness dimension were broken down into 37 questions which were put into questionnaires for each of the case studies. The questionnaire was developed based on information from literature (OECD 2009, OECD 2015, OECD 2015, Nava, Brown et al. 2016, Belmans, Campling et al. 2018, UN 2018), and the questions themselves related to different institutional levels and geographical scales, so that the coherence and consistency of EU legislation could be analysed at the local-regional level, as well as the implementation at the national level. As EU directives are often implemented on a sectoral basis (Keessen, Runhaar et al. 2011), the questionnaire applied to each of the relevant directives. The respondents to the questionnaires varied: some, for example, were filled out by the experts and MAP coordinators involved in the FAIRWAY project. For each country, 2 to 6 respondents filled out the questionnaires. If this expertise was not present in the project, external policy makers and experts were consulted who had a regional to local view. For all cases, the questionnaires were completed by multiple respondents and the results were discussed when different views arose.

Secondly, the principles within the other two dimensions of the analytical framework, Efficiency and Trust and Engagement, were analysed, such as regulatory frameworks, monitoring and evaluation and stakeholder engagement. To this end, a set of 14 questions was formulated. These questions were derived from an earlier study on governance approaches regarding drinking water resources in the Netherlands (Wuijts, Driessen et al. 2017). The answers to the questions were delivered in writing and then clarified further during carousel discussion sessions with the MAP coordinators. Both questionnaires can be found in the supplementary material.

Thirdly, the data were aggregated per principle and per country for further analysis. All the questionnaires that were filled out were collated in a spreadsheet, one for each directive studied, containing the results of all the individual questions, and clustered for the different OECD principles. Consequently, the results of the individual questions were first combined into a synopsis for the different directives, but separately for the different case studies and countries. Subsequently, the results were aggregated into a summarising text for each of the principles covering all of the case studies and contries. Two researchers from different countries in the FAIRWAY project carried out the aggregation of results individually and subsequently compared and discussed the results to avoid interpretative errors. The results of the analysis were reported back to the MAP coordinators for feedback and discussion.

Finally, the answers for the different countries were summarised into one concluding answer for each question, leaving room to highlight differences and similarities in implementation strategies between directives and countries that might affect effectiveness. These results were reported back to the experts and stakeholders involved for feedback and discussion. The different stages of the data collection and analysis are depicted in Figure 2.1.

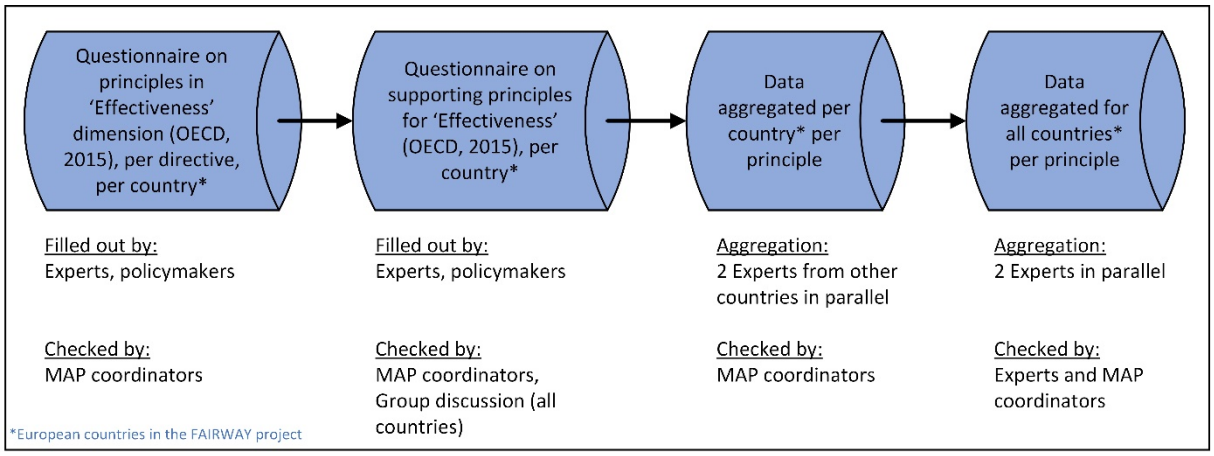



*Figure 2.1 Data-collection and analysis.*

### 3.2.4 Limitations and uncertainties

Data for this study was collected through interviews and questionnaires. Policy documents and (grey) literature on the case studies were used as additional source of information. Using this methodology meant that the results relied strongly on the level of expertise of the interviewees. Information not provided by an interviewee could thus be lacking in the analysis. Checks and balances were included in the process of data analysis to overcome this potential bias, by requesting that the questionnaires were filled out by pairs or groups, by complementing the questionnaires with group discussions with experts from other countries and cases, by analysing the data-set in parallel for countries other than your own and by asking the MAP coordinators to reflect on the final dataset.

## 3.3 RESULTS

In accordance with the central question of this analysis, this section is structured around three elements: (1) consistency of EU regulations, (2) coherence across sectors and levels, and (3) mode of implementation and the attainment of objectives at local level. The responses to the questions that are relevant to these elements are described here.

The total results of the aggregated questionnaires are summarised in the supplementary material.

#### *Consistency of EU regulations*

Consistency manifests itself in the degree to which commonly agreed policy objectives are recognised at different levels by different stakeholders and within different policy arenas. They must not contradict each other and this requires clarity about roles and responsibilities, and management across scales.

*Principle: Clear roles and responsibilities towards objectives*

All the countries studied have transposed the relevant EU directives into national law. The allocation of roles and responsibilities for each directive is clearly demarcated at national level in the planning phase, although assigned to different ministries. For the regional/catchment, local and farm level, the division of these roles and responsibilities for (strategic) planning for water quality ambitions often becomes less clear from the perspective of the respondents, although in all of the countries studied, farmers have to prepare a plan for the use of fertilisers.

*Principle: Appropriate scales within basin systems*

In most countries studied, except in the UK, different ministries are responsible for agricultural policy and environmental protection. The collaboration at national level between ministries and between water authorities was reported as being in place and working more or less for all the countries studied. The issue of governance at the appropriate scale within basin systems or other relevant scales, is not regarded as a major issue affecting effectiveness for the countries studied. More difficult is the involvement of different sectors, government departments and administrations, in addressing water quality issues from agriculture at different institutional levels and scales (e.g. Greece, Germany). At river basin and catchment level, good collaboration was reported too (e.g. Denmark, France and Norway) but not for all countries. In these collaborations, farmers' organisations are represented in several cases. The level of direct collaboration with individual farmers, however, differs between the countries studied.

*Principle: Capacity (towards objectives)*

Authorities in most cases have the capacity to lead, monitor and evaluate the execution of policy plans. Lack of staff and finances was frequently reported as an obstacle to carrying out all responsibilities (e.g. Germany, especially at the legislative level, and England). A decrease in these resources cascading from the national level to the regional/catchment level can be identified in some countries according to the interviewees (e.g. Greece, Netherlands), but it can also be the other way around: lack of staff at the top, national level, and sufficient staff at the bottom, e.g. providing farm advice (Germany).

*Principle: Stakeholder engagement*

Stakeholders involved include public authorities, water companies, farmers' organisations, industry associations, NGOs and experts, such as agricultural advisors and consultants. Several institutional levels are involved in the attainment of objectives at local level and interaction with stakeholders does not take place at all levels. In the case studies, farmers and local citizens are given the opportunity to be engaged. For some countries the stakeholder engagement set-up for the MAP in the case study is reported as a new way of collaboration (e.g. Slovenia, Romania and Greece).

Stakeholders in the MAPs of the case studies were engaged based on their interest in clean water, local knowledge, knowledge on best practices, such as catchment advisors (e.g. England, Portugal), sources of pollution (e.g. Slovenia, Netherlands, Germany, Denmark, Norway), established networks (e.g. Northern Ireland, Germany, Portugal) and the means

and power to act (e.g. Slovenia, Romania, Denmark). Norway reports that commercial private actors have not yet been included in the river basin committee because of their primarily economic focus. However, the importance of their role in the process has been acknowledged and dialogue is being channelled through other meeting arenas. Other reasons for restrictions are group size (to allow discussions) and costs (advisors), and England reports that some stakeholders are reluctant to speak if the regulator is also part of the stakeholder group.

Some countries report that different authorities from different institutional levels participate in the case study (e.g. Germany, Norway, France). Others report that there is a disconnect between the different levels (e.g. Greece) or a single layer governance approach (Slovenia). This may also differ for different case studies and regions in a country (e.g. Germany).

All countries stress the importance of environmental information, although socio-economic implications may play a major role in the decision-making when stricter measures need to be implemented (Germany). Citizen engagement has only been used in a limited way so far in the process of decision-making regarding the protection of drinking water resources. In Germany, there is a citizen science initiative which is collecting water samples and analysing nitrates from private groundwater extraction points and from surface waters (https://www.xn--vsr-gewsserschutz-wqb.de/nitratbelastung/, last accessed January 14th, 2021) and an initiative which is working on the methodology and publishes manuals in order to improve the validity of nitrates analysis (https://uol.de/aktuelles/artikel/stickstoffverbindungen-und-die-neugier-an-der-wissenschaft-3775, last accessed on January 14th, 2021). In England, citizen science is considered a fundamental opportunity for understanding and promoting local engagement in the Catchment Based Approach (https://catchmentbasedapproach.org/learn/citizen-science-volunteer-monitoring/, last accessed January 12th, 2021). Other factors mentioned as relevant in the process of decision-making are the overriding interest of the right to drinking water (Slovenia) and the costs for providing good quality drinking water (France).

*Experiences with consistency in the Derg catchment case study*

Textbox 2.1 outlines how the inconsistencies between EU directives and its application at farm level can negatively impact water quality in the Derg catchment case study (Republic of Ireland – Northern Ireland); a study which highlights the complexity of the interactions between European and national agri-environmental legislation, EU subsidy payments and catchment characteristics. In some cases these interactions can have detrimental impacts on water quality. The ND and SUPD limit agricultural pressure in intensively farmed catchments. However, in more marginal upland catchments they enable farmers to operate above the carrying capacity of the soil by including marginal land, cleared of rushes, in the total farm organic N loading calculations required for the ND. However, in practice, this livestock is often concentrated on the small number of higher-quality grazing fields on the farm, resulting in higher nutrient loads.

Furthermore, receipt of the Basic Payment Scheme (BPS) of the Common Agricultural Policy (CAP) is a vital income source for cattle and sheep farmers in upland catchments. In 2017/18, the cattle and sheep sector in Northern Ireland would have operated at a loss if the income from the BPS had been removed (DAERA, 2019b). Farmers are under pressure to maximise the eligible area for the BPS on their farm, the main driver for the control of rushes using MCPA. At the same time this hampers the sustainable preservation of drinking water resources.

*Textbox 2.1 Consistency agricultural and water quality policy in the Derg catchment.*

The poorly drained, acidic and nutrient-poor soils in the Derg catchment provide ideal conditions for the proliferation of rushes (*Juncus sp.*), which easily outcompete grasses in the absence of preventive management (Kaczmarek-Derda et al., 2019). At present, mapping indicates that rushes occupy approximately 5% of agricultural land in the catchment, which reflects efforts to suppress rushes and maintain grass cover (Cassidy 2018). These efforts are driven by targets set by both intensive and extensive farms in the catchment. In an intensive dairy system the control of rushes is driven by production and nutritional targets, while in part-time low intensity beef and sheep systems the main driver is to maximise the land area classed as "actively farmed" and eligible for area-based payments under the common agricultural policy (CAP) basic payment scheme (BPS). As such maintaining and maximising the eligible area, is a priority for both intensive and extensive farms in the catchment.

The eligible agricultural land area declared under the BPS is also used to calculate the organic N loading for each farm under the EU Nitrates Directive (ND) (91/676/EEC). The ND sets a limit of 170 kg organic N/ha which equates to a stocking rate of 2 Livestock Units (LSU)/ha. Exceeding this limit is only permissible if the farm applies for a derogation.

While farmers are required to apply the Code of Good Agricultural Practice for grazing (DAERA 2008) in order to prevent *inter alia* compaction, poaching and erosion, in practice stocking rates are often higher that suggested by estimates of grazing capacity. For example, based on the 2018 returns from the farm census (DAERA 2019), the current average stocking rate in the catchment is 2.4 LSU/ha. This figure indicates that the overall stocking rate in the catchment is above the carrying capacity of the soil and can only be maintained through measures such as the installation of artificial drains and the intensive management of land through nutrient applications, liming, grazing, cutting, harvesting and reseeding.

In addition, the use of herbicides, particularly 2-methyl-4-chlorophenoxyacetic acid (MCPA), to suppress rush growth is widespread. Because there are only a limited number of fields available to produce high dry matter forage crops, farmers will periodically apply MCPA to these fields to reduce the risk of rushes or other broad leaf weeds impacting silage quality. In less intensively

### *Coherence across sectors and levels*

Coherence elucidates the extent to which laws and policies systematically reduce conflicts and promote synergies between, and within, different policy areas to achieve the outcomes associated with jointly-agreed policy objectives (Nillson, Zamparutti et al. 2012), imposing demands on regulatory frameworks, roles and responsibilities, decision-making and management across scales.

*Principle: Clear roles and responsibilities*

The tools reported which facilitate collaboration in water quality management at a specific level (horizontal collaboration) are: (1) a pesticide forum that brings together a range of organisations and is highlighted as having a key role under the national action plan in providing stakeholder interaction (England), (2) incentives from cross compliance and enforcement to adherence of good agricultural practice (Slovenia, Portugal and Germany),

(3) interdepartmental committees and county offices (Romania and Norway), (4) advisory boards for river basin management committees (Portugal), state regional representatives (France), (5) water councils (Denmark) and (6) a leading role for water agencies (Slovenia). Collaboration tools reported which facilitate policy coherence are focused primarily at national or river basin level, although there are exceptions.

In Germany for instance, joint working groups are meeting regularly for coordination purposes at national, federal, and river basin levels for both the WFD and the ND.

Obstacles to effective horizontal collaboration between different authorities and agencies mentioned are: competing interests between sectors and institutional levels (Norway, England, Germany, Romania, Slovenia), municipal stakeholders being involved in the management of water companies (e.g. England, Portugal), the lack of monitoring data (Slovenia) or access to data (France, Germany), limited decision-making powers or round table setting (Germany), lack of staff (Germany [at national level] and France) and citizen engagement (Portugal).

*Principle: Appropriate scales within basin systems*

The issue of management at appropriate scales is not regarded as a major issue hindering coherence for the different countries studied but the involvement of different sectors working in the field of agriculture and water quality is considered to be more relevant (e.g. Germany and Greece). River basin management committees (Slovenia, Netherlands, France and Denmark) and sub-basin committees (Norway) are reported as successful bridging mechanisms between different sectors. Similar examples are given for protection zones and nitrate vulnerable zones. The whole of Slovenia, because of its size, has been designated as a nitrate vulnerable zone and all issues are, therefore, addressed at national level. A similar approach has been followed by Austria and the Netherlands. This choice however, sets demands to the monitoring of nitrates in order to identify agricultural contributions (91/676/EC, Article 5.6) and develop appropriate nitrate action programmes (ECJ case law (C-481/18, C-197/18)). Germany cites a working group for the sustainable use of pesticides implementation (participated in by national and federal governments) as a good example of the bridging between administrative borders.

*Principle: Policy coherence*

Instruments which were reported to promote policy coherence relevant to horizontal collaboration in water quality governance, include: multi-sectoral conferences (e.g. Germany, Greece, Norway), conferences for transboundary river basins (Portugal, Romania), interdisciplinary workshops (Netherlands), inter-agency programmes for specific issues (Northern Ireland, Portugal and Norway), information sharing with the agri-food-industry (Northern Ireland) and guidance on best practices (England). Some countries reported limited horizontal communication (e.g. France, Greece) and lack of clarity in responsibilities (water and agriculture).

*Principle: Regulatory frameworks in place and enforced*

Regulatory frameworks and enforcement play an important role in achieving jointly-agreed policy objectives, although there are different views regarding the right balance between

voluntary and legally-based measures to support these objectives. Some countries rely primarily on legally-based measures (e.g. Portugal, Germany) and thus have a strong role for enforcement, other countries are more committed to voluntary measures and enforcement plays a less important role in practice (e.g. Netherlands, France), or there is a mix of both types of measures (e.g. Denmark and Norway). Economic incentives, such as compensation, play an important role in relation to both voluntary and mandatory measures (e.g. Denmark, Germany and Norway). Norway refers to the information provided by the municipal agricultural advisor, the MAP coordinator and research projects as an incentive, for instance in cases where there is disagreement about the cause of a problem.

*Principle: Transparency and integrity in decision-making*

Conflict prevention and resolution are addressed in different ways. For example, Northern Ireland refers to the communication plan in The Rivers Trust for the Source To Tap project as a means, Germany (Lower Saxony) to Round Tables for Agriculture and Water Protection and the Netherlands to the agricultural advisor as arbiter. Legal procedures are rarely used in practice for conflict resolution regarding nitrate and pesticide pollution e.g. caused by difficulties related to control and proof of an offence (Germany).

Mechanisms reported to support conflict management and resolution are the arbiter role of the municipal agricultural advisor and MAP coordinator (Norway, Netherlands), cross-compliance (Portugal), financial incentives (Germany: Farmer-waterworks cooperation), compensation and land consolidation (Denmark), agricultural support (France, Germany), public consultation and the role of civil initiatives (Slovenia).

*Experiences with coherence in the Lower Saxony case study*

The Lower Saxony case study (Germany, see Textbox 2.2) describes how parallel policy objectives regarding biogas production and fertilisation can result in negative impacts on water quality. Increasing amounts of manure and biogas by-products create a bottleneck in their application in regions with high livestock densities, resulting in rising nitrate levels in groundwater. To remediate this development, manure treatment and export to other regions and federal states are increasing (Landwirtschaftskammer Niedersachsen 2020). In regions with a focus on arable farming and little livestock breeding, there is potential to substitute part of the mineral fertilisers with manure from the intensive animal breeding regions. However, there are many factors which hamper application in practice such as: (1) the limited nitrogen surplus which is legally acceptable according to the German Fertilisation Ordinance (2017, 2020) and the possibility of exceeding this limit when using manure or other organic fertilisers; farmers in arable regions under this condition tend to use mineral fertilisers, (2) obstacles to improving the nitrogen efficiency of fertilisation by the timely supply of baseline data ($N_{min}$-values in spring) to farmers by farm advisors and delays in the national implementation of new techniques, (3) the possibility of health risks related to untreated manure caused by limited hygiene standards for farmyard manure in the Fertiliser Ordinance (2012) and (4) the lack of manure storage capacity in arable farming areas, as local authorities hesitate, or even refuse, to grant building permits for storage facilities. Due to pressure from the European Commission, the duty to set up a nitrogen soil surface budget and the necessity of not exceeding a certain level of nitrogen surplus was abolished and replaced by the duty to record the fertilisers applied (Fertilization Ordinance 2020).

*Textbox 2.2 Coherence water, fertilisation and energy policy: case study Lower Saxony (Germany).*

Since 2000, the installation of biogas plants has been subsidised as a result of the passing of the German Renewable Energy Act (EEG, 2000, 2004, 2008). The law was adopted in 2004 and 2008, each time with more favourable conditions for the electric energy produced by cogeneration units of biogas plants. From the beginning of 2009, biogas plants operating with > 30% manure received even higher subsidies. As a result, the number of biogas plants installed increased from 600 in 2010 to 1,174 in 2018 (3N Kompetenzzentrum, 2020) and, in turn, increases the total amount of organic fertilisers (Meergans and Lenschow, 2018). The German Fertilisation Ordinance (2007), and the national implementation of the Nitrates Directive (1991), could not block this development, as the 170 kg/ha limit it prescribed for organic nitrogen in the national implementation only referred to N from animal manure. Consequently, after years of decreasing concentrations of nitrates, since 2011/2012 in the north-western region of Lower Saxony, the trend for the average yearly concentration of nitrates in groundwater of selected wells reversed and showed a marked increase in 2017 exceeding nitrate standard of 50 mg/l (Roskam 2018).

To counter this development, Lower Saxony issued a ministerial decree (ML, MS, MU, 2015), which obliged biogas plants to provide references to prove that the biogas residues they produce would be used according to the good agricultural practice defined in the national Fertilisation Ordinance.

In the adapted German Fertilisation Ordinance (2017), the 170 kg/ha limit also includes other types of organic and organic-mineral fertilisers and soil conditioners besides manure such as biogas residues, compost and sewage sludge.

### *Mode of implementation and the attainment of objectives at local level*

The role of the mode of implementation and the attainment of objectives at local to regional level comes forward most explicit in the questions related to the principles ‘Appropriate scales within basin systems’, ‘Policy coherence’, ‘Capacity’, ‘Data and information’, ‘Regulatory frameworks in place and enforced’ and ‘Trade-offs across users, rural and urban areas and generation’.

*Principle: Appropriate scales within basin systems*

Management instruments to support drinking water pollution control are used by all the countries studied, but different strategies are chosen by individual countries to facilitate use across levels and scales. England and Germany report a high degree of advice and guidance for farmers at catchment and farm level to support the implementation of a high level of regulation cascading from national and regional levels. Slovenia, Germany and Portugal stress the strong role of enforcement and cross-compliance. Other countries refer to the importance of monitoring and reporting and the development of programmes of measures from the WFD (e.g. France, Norway, Denmark). For Greece, a large variation was reported between management instruments used for the different directives. In Norway regional drinking water authorities are invited to comment on municipal spatial planning.

The designation of safeguard zones around drinking water resources was frequently put forward as a successful instrument for protection. Other (mandatory) instruments mentioned are the use of monitoring to support the evidence base and the development of programmes to support a sustainable use of pesticides (education on use by farmers, e.g. Portugal,

Norway, Germany and UK [‘Get Pelletwise' Campaign]) and manure (nitrate vulnerable zones, Greece).

*Principle: Policy coherence*

Vertical coordination across different levels of governance in relation to nitrate usage is reported as limited for several countries. Obstacles reported are data protection at farm level (Germany), a disconnect between national policy and bottom-up initiatives (Netherlands, England), fragmentation of policy objectives (Norway), overlapping responsibilities (Greece) and a lack of funding for local collaboration (Greece, Slovenia).

*Principle: Capacity (at the local level)*

Several governance measures were adopted by countries to build capacity to deliver water policy measures. Collaboration with the private sector (public authorities, private water companies and the agri-food industry) is reported. In England, the agency called Natural England (a non-departmental public body, sponsored by Defra) has teams of catchment advisors. This organisation enhances collaboration further by contracting private consultants to deliver water advice to farms. The Environment Agency makes Catchment Base Approach (CaBA) grants available to host catchment’s partnerships. Some countries report the blocking role of GDPR (General Data Protection Regulation, EU/2016/679) for data sharing between local projects.

*Principle: Data and information*

Most countries studied report that measures taken are based on knowledge of issues, interventions that could be enabled, and the opportunities offered by the legal framework which vary from country to country as their legal frameworks differ. Several countries rely on voluntary based measures where interventions may be linked less explicitly to nitrate and pesticides reduction and may be driven by economic motivations as well. Knowledge is based on scientific studies and best practices in other areas. Agricultural advisors play an important role. Not enough feedback has been received about the use of ‘learning by doing’ (adaptive capacity) to improve the effectiveness of interventions.

*Principle: Regulatory frameworks in place and enforced*

The role of legally based measures varies strongly between countries, but this does not provide any indication as to the mode of implementation at the local level. Countries may have opted for a larger proportion of voluntary based measures and yet have attained the objectives at local level. The link between voluntary measures and water quality improvement is more ambiguous, because other interests, from farmers or other stakeholder groups, may play a more important role. Legally based measures on the other hand, should be achievable, enforceable and capable of reducing emissions to the levels required (e.g. ECJ case law C-266/99, C-165 to 167/09, C-237/07). This level of scrutiny is required in all environmental compartments, according to the European Commission (EC 2017).

*Principle: Trade-offs across users, rural and urban areas, and generations*

The role of trade-offs in costs, benefits and distributional effects of various alternatives in agreed service level decisions, is dependent on how many of the measures that need to be taken are legally based. Portugal for instance, which has a strong legal base for the measures that need to be taken, uses the 'polluter pays' principle, which is anchored in the legal framework. For other case studies, which rely more on voluntary based measures, a balanced trade-off between costs and benefits for farmers, is much more prominent in the selection of measures (e.g. Denmark, Netherlands, Northern Ireland and Norway).

*Experiences with mode of implementation and objectives' attainment in the Axios case study*

The Axios case study (Greece) (see Textbox 2.3) shows how the introduction of the MAP can serve as a bridging mechanism to promote coherent policy implementation and objectives' attainment at local level. So far, complicated and fractured legislation, unclear or overlapping responsibilities, the lack of rules for verification and validation, the distribution of financial means across institutional levels and the limited use of instruments for compliance and enforcement have been reported as factors hampering the realisation of water quality ambitions.

Farmers are often not very aware of their legal obligations regarding water quality. Most of the farms in this part of Greece are family businesses with small capital and no long-term plan. Farmers would, therefore, need incentives such as capacity building and starting grants for every single change in their production, but the continuity of such incentives is a point of concern.

*Textbox 2.3 Mode of implementation and objectives' attainment in the Axios case study (Greece).*

The ruling of the European Court of Justice (ECJ, C-149/14) that the implementation of the ND in Greece lacked any targeted action programmes has resulted in the development of Nitrate Action Programmes in the Nitrate Vulnerable Zones, but their implementation is taking place at a slow pace. In this process, a disconnect can be identified between the policy making at national level and the realisation at regional or local level.

The local discontent regarding the overlapping legislation, the multitude of institutions and government services responsible for planning and implementation, and the pressure from the European environmental legislation, have led to the establishment of the Directorate of Environment, Industry, Energy and Natural Resources of Central Macedonia Prefecture that cooperates with the local directorate of development and environment of the Kilkis Prefecture.

This rearrangement created a more centralised approach in the management of water resources, leading to a better and higher funding opportunity for large waterworks and a top-to-bottom implementation of rules and legislation from the EU and the establishment of directorates for water management in every region. In this way, the legislation became somewhat clearer at local to regional level and the problems for each region became apparent. But the small and everyday issues are not addressed this way, so the role of regional water utilities and water councils should be strengthened.

To this end, a multi-actor approach (MAP) was set up in the Axios case study area to address groundwater pollution. The MAP aims to involve farmers, companies providing advice, regional government, water boards, the pesticide industry, farmers, contractors, public authorities, and consumers and inform them about the monitored effects of their practices on water quality objectives and facilitate action.

*Table 2.3 Summary of results* for the *criteria coherence, consistency and the attainment of objectives at the local level, structured by the principles of the OECD framework (OECD, 2015).*

| **Dimensions and Principles**<br><br>**Analytical framework (OECD, 2015)** | | **Consistency of EU regulation** | **Coherence across sectors and levels** | **Mode of implementation and attainment objectives at local level** |
|---|---|---|---|---|
| **Effectiveness** | Capacity | Authorities mostly have the capacity to lead, monitor and evaluate. Others lack staff. Finance is reported frequently as an obstacle at different levels. | | Several governance measures have been adopted to build capacity to deliver water policy measures, such as public-private collaboration. |
| | Policy coherence | | Instruments reported for policy coherence relevant to horizontal collaboration include multi-sectoral, transboundary, interdisciplinary conferences, inter-agency programmes for specific issues, information sharing with the agri-food-industry and guidance on best practices. | Limited vertical coordination across different levels of governance for several countries is reported because of the fragmentation of policies, disconnected bottom-up and top-down initiatives and data-protection at farm level. |
| | Appropriate scales within basin systems | EU directives are implemented on a sector-by-sector basis. Good collaboration reported at national level. Cross-sectoral collaboration can be more difficult at the lower levels. Scale is not considered a major issue for effectiveness. | Similar to consistency of EU regulations, the issue of scale not regarded as a major issue for coherence in the different countries studied. The involvement of different sectors is considered to be more relevant. | All countries use management instruments to support drinking water pollution control across scales, yet strategies differ. E.g. advice, participation, protection zones, special programmes. |
| | Clear roles and responsibilities | All countries have transposed EU directives into national law. All countries identify clear roles and responsibilities at national level for the planning stage. Less clarity exists at | Collaboration tools for policy coherence focus on national or river basin level, although there are exceptions. Obstacles reported: competing interests across levels and sectors, | |

| Dimensions and Principles<br><br>Analytical framework (OECD, 2015) | | Consistency of EU regulation | Coherence across sectors and levels | Mode of implementation and attainment objectives at local level |
|---|---|---|---|---|
| | | lower levels and during the realisation of policy objectives. | access to data, limited decision-making powers, lack of staff. | |
| Efficiency | Regulatory frameworks in place and enforced | | Regulatory frameworks and enforcement play an important role in achieving jointly agreed policy objectives. Different views exist on the balance between voluntary and legal based measures. | Strong variation between countries on the role of legally-based measures and enforcement. Some countries have more voluntary based measures and yet have realised objectives at local level. Other interests, from farmers or other stakeholder groups may, therefore, play a more important role. |
| | Data and information | | | Measures are based on knowledge of issues, effects and possibilities of legal framework. Some voluntary measures are less linked to water quality improvement and may be linked to economic motivations as well. |
| Trust and Engagement | Trade-offs across users, areas, and generations | | | For countries that rely on voluntary based measures, the selection of measures is usually a balanced trade-off of costs and benefits for farmers. There is, however, little focus across generations. |
| | Stakeholder engagement | Stakeholder interactions do not occur at all levels. Motivations for engagement or not are: established networks, means and power to act, group size and costs. | | |

| Dimensions and Principles<br><br>Analytical framework (OECD, 2015) | | Consistency of EU regulation | Coherence across sectors and levels | Mode of implementation and attainment objectives at local level |
|---|---|---|---|---|
| | | MAPs are a new way of engagement for some countries. | | |
| | Integrity and Transparency | | Conflict prevention and resolution are addressed in different ways. Legal procedures are seldom used, as it is difficult to prove an offence has been committed. | |

## 3.4 DISCUSSION

This study analysed the implementation of EU regulations in 11 different European countries and their effectiveness in 13 local governance arrangements for the protection of drinking water resources against agricultural pressures. We focussed on lessons that could be learnt regarding the coherence and consistency of the implementation of EU directives and their effects at local level (overview of results in Table 2.3). The OECD Principles on Water Governance (OECD 2015) were used as our analytical framework.

*Complexities and inconsistencies of the European legal framework*

At EU level, regulations and policies for agriculture and the protection of drinking water resources are explicitly linked (Platjouw, Moore et al. 2019). For instance, the Nitrate Directive (91/676/EEC) links to the objectives of the Drinking Water Directive (98/83/EC) and the WFD (2000/60/EC) forms an overarching framework for EU directives regarding specific water functions (e.g. drinking water, shellfish waters, bathing water), the use of chemicals and their effect on the environment and the state of Europe's waters themselves. Although the directives are linked, their implementation produces collateral effects that hamper the effective protection of drinking water resources. The rules on the application of fertilisers, for example, are not always beneficial to groundwater and drinking water quality.

The implementation of the EU Directives often takes place along parallel tracks, and frequently under the responsibility of different ministries. Inconsistencies in agricultural policy that hamper an effective protection of drinking water resources, may therefore not manifest themselves at first sight and at all institutional levels. Examples reported of these inconsistencies are a disconnect between water quality standards and application rules for manure and pesticides, the issue of scale for evaluation, side effects of land use subsidies and incentives on water quality and the role of hydrogeology and geochemistry in the effects of land use policy (Platjouw, Moore et al. 2019). Earlier studies confirm that existing legal frameworks are insufficient to adequately protect drinking water resources from agricultural pollution (Keessen, Runhaar et al. 2011, Doody, Foy et al. 2012, Duncan, Morris et al. 2014, Jacobsen, Anker et al. 2017). For instance, the allocation of roles and responsibilities differs between directives which means cross-sectoral collaborations take place across different institutional levels. Some of these differences can be explained by the evolution of EU legislation over time, caused by a greater understanding of water systems and societal and economic developments. The more explicit role of the subsidiarity principle in the WFD means that decision-making on waterbody-specific objectives and measures takes place at regional or local level, whereas implementation of the ND primarily takes place at national level (Kastens and Newig 2007, Hüesker and Moss 2015, Van Rijswick and Keessen 2017).

*Coherence of cross-sectoral connections at different levels*

The collaboration tools reported primarily focus on the national or river (sub)basin level. In the countries studied, river basin management committees and sub-basin committees are reported to be successful bridging mechanisms between different sectors although the involvement of different sectors (e.g. agriculture, retail) can be difficult.

Multi-sectoral conferences and workshops, inter-agency programming for specific issues, information sharing with the agri-food-industry and guidance on best practices came forward as successful instruments for horizontal collaboration. Yet they all focus on the national or river basin level. At local or regional level, competing interests between different sectors manifest themselves

more explicitly, while decisions need to be made on actual measures at these local scales. Similar experiences regarding collaboration at different levels and scales have been described for other countries or regions (Andersson, Petersson et al. 2012, Blackstock, Waylen et al. 2014).

*Mode of implementation and attainment of objectives at local level*

Individual countries have opted for their own strategies to facilitate the implementation of EU directives across levels and scales. Various authors describe the differences in the mode of implementation between countries and the effects this may have on achieving policy objectives (Keessen, Van Kempen et al. 2010, Giakoumis and Voulvoulis 2018). These studies however, have often taken a sectoral perspective rather than a systemic one.

Most of the instruments reported in this study can also be characterised as sectoral approaches that originated from individual directives which developed along parallel tracks. This implies that, at local level, these sectoral approaches have to all be put into practice together in order to achieve coherency and to be effective in the achievement of water quality objectives. This observation suggests that conditions of governance regarding, for instance, capacity, authority, instruments and means for all sectors at stake, need to be in place at local level if this is to be achieved (Wuijts, Driessen et al. 2017). For several countries, a lack of funding for local collaboration was reported as one of the obstacles.

For the countries studied, the designation of safeguard zones around drinking water resources was frequently mentioned as a successful instrument for protection, yet requires coherence in the implementation of the different relevant directives in most of the countries studied. How this coherence could be achieved might be different for different institutional levels. Buijze (2015) concludes that generic rules do not function well under all circumstances, and at all levels and scales, whereas instrumental rules are not necessarily problematic and sometimes essential, for instance, in the allocation of roles and responsibilities. Citizen engagement was reported by several countries as an important driver for environmental protection policy.

*Reflections on the analysis*

The case studies used for this research focus on water quality issues raised by the use of nitrates and pesticides originating from agricultural emissions and leaching. However, emerging contaminants from agricultural practices (e.g. veterinary pharmaceuticals, antibiotic resistant bacteria, zoonoses) are relevant threats to the quality of drinking water resources as well. To include these in the analysis would require an additional assessment of other EU Directives such as the Community Code relating to veterinary medicinal products (2001/82/EC) and related directives. This could be an interesting avenue for future research.

The analytical framework used for this study (OECD 2015) facilitates an understanding of the strengths and weaknesses of a governance approach. The framework identifies twelve principles within three dimensions, i.e. effectiveness, efficiency and trust and engagement (see Table 2). The structure of the framework suggests that there is a clear division between the three dimensions which would allow for a separate analysis of the principles related to one dimension. As the central question for our study was to explore the effectiveness of EU regulations on the local restoration and protection of drinking water resources from agricultural pollution, our initial proposition was to study the principles related to the ‘effectiveness’-dimension. However, the initial data showed that the interlinked principles from the other dimensions had to be taken into account as well. For this reason, the questionnaires were followed up by interviews where additional questions focusing on

these other principles were put. The questionnaires developed for this study may also be used to offer guidance on the use of the framework.

The methodology used for data collection involves the risk of a potential bias in the results. Information not provided by an interviewee could be lacking in the analysis. The checks and balances included in the process of data analysis proved to be of added-value in increasing the quality of the data. Scientific literature to date has only described a few examples of local-regional experiences, but other, more sectoral studies on national implementation (Kastens and Newig 2007, Keessen, Runhaar et al. 2011, Voulvoulis, Arpon et al. 2017), show similarities in the results from the questions on national implementation. The results provide an impression of experiences gained on the protection of drinking water resources from agricultural pollution throughout Europe. These insights could be established in greater detail if complementary case studies were made.

## 3.5 Conclusions

This study aimed to identify lessons that could be learnt regarding the coherence and consistency of European legislation to protect drinking water resources from agricultural pollution at local level. The results show that the complexities and inconsistencies of European legislation become most explicit at local level where cross-sectoral measures have to be taken and effects monitored. There they hamper the achievement of water quality objectives. The upcoming revision of the WFD should strengthen the links between the different directives and their objectives in this field and reduce inconsistencies.

Case studies examined in this article show that, as implementation often takes place along parallel tracks, cross-sectoral connections between water policy and other policy domains (e.g. energy, agriculture, nature) often need to be achieved at regional or local level. But it is at this level where a lack of knowledge on the legislative framework, the complexity of water system's responses and the role of different, and often competing interests, block the formation of such connections.

In some case studies there is a plethora of arrangements at farm level that cannot be (directly) linked to national and EU legislation. A more facilitated cross-sectoral approach to policy application at local level should be adopted to improve stakeholder networks, and between institutional levels and hydrological scales, so that higher effectiveness could be achieved.

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**Declaration of Interests**

No potential conflict of interest was reported by the authors.

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# ANNEX I QUESTIONS

Questions hold both semi-quantitative (scoring within a range) and qualitative elements (explanation of the score).

*Table I.1 Questionnaires used for the data collection.*

| OECD Principles | | Questions | |
|---|---|---|---|
| | | Q1-Q6 | General introducing questions |
| 1 | Roles and Responsibilities | Q7 | What is the status of the transposition of the directive into country/ Case Study law?<br>*Scoring, scale 1 to 6:*<br>1 - Development not started or delayed in most subnational jurisdictions<br>6 - Objectives consistently achieved by all authorities, and periodically reviewed and revised |
| | | Q8 | What is the status of the allocation of responsibilities for strategic planning under this directive? Distinguish the different scales: national, regional, river basin, catchment level, farm level.<br>*Scoring scale 1 to 6:*<br>1 - No obvious demarcation of roles and responsibilities<br>6 - Roles and responsibilities very clearly demarcated with no overlaps |
| | | Q9 | What is the status of the allocation of responsibilities for policy implementation for this directive? Distinguish the different scales: national, regional, river basin, catchment level, farm level.<br>*Scoring scale 1 to 6:*<br>1 - No obvious demarcation of roles and responsibilities<br>6 - Roles and responsibilities very clearly demarcated with no overlaps |
| | | Q10 | What is the status of coordination and the collaboration between government authorities and agencies in relevant sectors? Distinguish the different scales: national, regional, river basin, catchment level, farm level.<br>*Scoring scale 1 to 6:*<br>1 - Development not started or not progressing<br>6 - Objectives consistently achieved and periodically reviewed and revised |
| | | Q10a | Which coordination tools for policy coherence are relevant to horizontal collaboration in water policy making? Distinguish for river basin organisation/agencies, regulations for sharing roles between |

| OECD Principles | | Questions | |
|---|---|---|---|
| | | | Actors, co-ordination agency or commission, contractual arrangements, intermediate bodies or actors, financial transfers or incentives<br><br>*Scoring scale 1 to 6:*<br>1 - Development not started or not progressing<br>6 - Objectives consistently achieved and periodically reviewed and revised |
| | | Q11 | What are the most frequent obstacles to effective horizontal collaboration between different authorities and agencies? Distinguish for overlapping, unclear, non-existing allocation of responsibilities, intensive competition between different ministries, interference of lobby groups, absence of common information and frame of reference for policy makers, lack of high political commitment and leadership in water policy, lack of institutional incentives for co-operation, lack of staff and time, lack of technical capabilities, difficult implementation of federal government decisions at local and regional level, absence of strategic planning and sequencing of decisions, absence of monitoring and evaluation of the outcome of national/regional legislation, contradiction between national agencies and supranational recommendations/directives, lack of citizens concern on water policy.<br><br>*Scoring scale 1 to 6:*<br>1 - Highly obstructive to coordination between different administrative agencies/entities<br>6 - Highly collaborative and effective coordination between different administrative agencies/entities |
| | | Q11a | Please select two of the most significant obstacles (either from the list above or from your own suggestions) and provide a more in depth description |
| 2 | Scale | Q12 | What is the status of management instruments used to support drinking water pollution control? Distinguish the different scales: national, regional, river basin, catchment level, farm level.<br><br>*Scoring scale 1 to 6:*<br>1 - No management instruments being implemented<br>6 - Management instruments are implemented on a long term basis, with excellent coverage across sectors and the country and are highly effective |
| | | Q12a | Please provide two management instruments which are considered successful in your country and an explanation of how they function and what they achieved. |
| | | Q13 | Is there a mechanism for ensuring policies are set at the appropriate geographic scale? For example, between hydrological boundaries and administrative boundaries<br>*Scoring scale 1 to 6:*<br>1 - There are issues and no mechanisms in place<br>6 - All required mechanisms for bridging scales of governance have been recognised and implemented by the majority of authorities |

| OECD Principles | | Questions | |
|---|---|---|---|
| | | Q13a | Please provide two bridging mechanisms that proved to be successful in your country and a few lines explaining how they function and what has been achieved |
| | | Q14 | What is the status of management instruments used to support implementing of water quality monitoring? Distinguish the different scales: national, regional, river basin, catchment level, farm level.<br><br>*Scoring scale 1 to 6:*<br>1 - No monitoring systems in place<br>6 - Long-term monitoring is carried out with excellent coverage and excellent use by stakeholders |
| | | Q14a | How important are the below performance indicators in monitoring and evaluating policy? Distinguish environmental, social, economic, citizen indicators.<br><br>*Scoring scale 1 to 6:*<br>1 - No monitoring systems in place<br>6 - Long-term monitoring is carried out with excellent coverage and excellent use by stakeholders |
| | | Q15 | What is the status of the framework for transboundary water management for the most important basins?<br><br>*Scoring scale 1 to 6:*<br><br>1 - Development not started or not progressing<br>6 - Objectives consistently achieved and periodically reviewed and revised |
| | | Q16 | What is the current status for the transboundary data and information between countries?<br>*Scoring scale 1 to 6:*<br><br>1 - Development not started or not progressing<br>6 - Objectives consistently achieved and periodically reviewed and revised |
| | | Q17 | Transboundary comments |
| | | Q18 | What are the current levels of public participation at each level of governance below? Distinguish the different scales: national, regional, river basin, catchment level, farm level.<br><br>*Scoring scale 1 to 6:*<br><br>1 - No communication between government and stakeholders on policy, planning and management<br>6 - Representation: Formal representation of stakeholders in government stakeholders in government processes contributing to decision making on important issues and activities, as appropriate |
| | | Q18a | Are there mechanisms or regular assessments of stakeholder engagement, for example, measuring costs or other obstacles? Please explain. |

| OECD Principles | | Questions | |
|---|---|---|---|
| 3 | Policy coherence | Q19 | What is the current status for data and information sharing with each level below? Distinguish the different scales: national, regional, river basin, catchment level, farm level.<br><br>*Scoring scale 1 to 6:*<br>1 - No data and information sharing<br>6 - All relevant data and information are online and freely accessible to all |
| | | Q20 | Which coordination tools for policy coherence are relevant to horizontal collaboration in water policy governance? Distinguish multi-sectoral conferences between central governments, platforms for sharing information between industry experts, inter-agency programme (two or more organisations working together).<br>*Scoring scale 1 to 6:*<br>1 - Development not started or progressing<br>6 - Being used by authorities and consistently achieved, and periodically reviewed and revised |
| | | Q21 | What are the most frequent obstacles for effective vertical co-ordination across different levels of governance? Distinguish lack of consistency in information exchange between groups in vertical<br><br>coordination, fragmentation of water governance, disproportionate funding impacting the effectiveness of water governance, insufficient technical knowledge, infrastructure undermining the implementation capacities of local actors.<br>*Scoring scale 1 to 6:*<br>1 - Obstacle blocking effective coordination<br>6 - Strategies to manage obstacles are in place, working and periodically reviewed and revised |
| 4 | Capacity | Q22 | What is the status for the authorities' resource (people/ finance/ infrastructure) for leading governance of water policy measures? Distinguish the different scales: national, regional, river basin, catchment level, farm level.<br><br>*Scoring scale 1 to 6:*<br>1 - No dedicated government authorities to lead<br>6 - Authorities have the capacity to effectively lead periodic revisions |
| | | Q23 | Which broad governance measures have been adopted to build capacity to deliver water policy measures? Distinguish collaboration with the private sector, financial incentives, performance indicators and targets holding local government accountable, citizen participation, involvement in civil society organisation, data bases (sharing information).<br>*Scoring scale 1 to 6:*<br>1 - Development of measures started or not progressing<br>6 - Measures in place and consistently used and periodically reviewed and revised |
| 5 | Data & Information | Q24 | Are measures based upon knowledge of issues, possible interventions and possibilities of the legal framework? |

| OECD Principles | | Questions | |
|---|---|---|---|
| 7 | Regulatory frameworks in place and enforced | Q25 | Are regulations and agreements enforceable by public and/or private parties, and are there appropriate remedies available? |
| 9 | Transparency and integrity in decision-making | Q26 | How are conflicts prevented or addressed? |
| | | Q27 | What mechanisms are in place? |
| | | Q28 | Are they used? |
| 10 | Stakeholder engagement | Q29 | How are stakeholders (actors) selected and involved? |
| | | Q30 | Is this selection based upon the analysis where the pollution comes from, who is affected and who has the power to act with relevant measures? |
| | | Q31 | What stakeholders are not involved and why? |
| | | Q32 | How is the interaction with upstream/ downstream actors and other institutional levels organised? (if relevant) |
| | | Q33 | How is the stakeholder involvement valued by the stakeholders themselves (in terms of better informed, efficient decision making) |
| 11 | Trade-offs across users, rural and urban areas, and generations | Q34 | Are agreed service level decisions based on trade-offs of costs, benefits and distributional effects of various alternatives? |
| | | Q35 | How does decision making take place? |
| 12 | Monitoring and evaluation of water policies | Q36 | Is there monitoring on outcome in terms of water quality improvement? |
| | | Q37 | Are programmes of measures being adapted upon the monitoring results? |

# ANNEX II SUMMARY OF RESULTS QUESTIONNAIRES

Table II.1 Results for OECD principles in the dimension 'Effectiveness' (OECD 2015).

| Principle | | Results from interviews |
|---|---|---|
| 1 | Clear roles and responsibilities | All countries have transposed relevant directives into national law. Greece and Germany have received notifications for not meeting the requirements of the ND. Germany has adopted on May, 1st 2020 towards a stricter implementation of ND. Greece the lack of plans for nitrate minimization in vulnerable areas had to be overcome (ECJ C-149/14). Norway as an European Free Trade Association (EFTA member) implements all the focal directives of this report.<br><br>The allocation of roles and responsibilities is clearly demarcated at the national level in the planning phase. For the regional/catchment, local and farm level, the division of these roles and responsibilities for (strategic) planning often becomes less clear, , although in most of the countries studied, farmers have to prepare a plan for the usage of fertilizers and pesticides and specify, for pesticides, records of spraying, how to protect the aquatic environment, and integrated pesticide management.<br><br>Implementation takes place at the river basin, regional or catchment level. The preparation of river basin management plans in Denmark takes place at the national level. Other countries may have more regionally oriented river basin committees, in which all actors involved are represented (e.g. Portugal). Such committees by themselves however have no formal authority. Farmers are in some cases represented in these committees (e.g. Norway and the Netherlands). In Norway there is on river basin (district) level a distinct reference group, on sub-basin (sub-district) level there are representatives from farmer organisations present (observation status).<br><br>In most countries studied, except for UK and Denmark, different ministries are responsible for agriculture and environmental protection. Collaboration at a national level between ministries and between water authorities was reported as in place and working. Focusing on the river basin and catchment level good collaboration has been reported as well (e.g. Denmark, France and Norway). In these relationships farmers organisations may be represented, but there is little direct collaboration with individual farmers and often limited to the case study areas (e.g. Overijssel (Netherlands)).<br><br>Collaboration tools reported were a pesticide forum brings together a range of organisations, key role under the national action plan in providing stakeholder interaction (England), incentives from cross compliance and enforcement to adherence of good agricultural practice. Inter-administrative commissions and county offices (Romania and Norway) and advisory boards for river basin management committees (Portugal), state regional representatives (France) and a leading role for water agencies (Slovenia). Due to the federal structure of Germany, co-ordination agencies or commissions (joint working groups) with contractual arrangements are established at the national, federal, and river basin levels both for the WFD and |

| Principle | | Results from interviews |
|---|---|---|
| | | ND. Additionally to already identified sharing of roles between actors, co-ordination agencies or commissions (joint working groups) with contractual arrangements are established in Germany at the national, federal, and river basin levels both for the WFD and SUD directives<br><br>Obstacles to effective horizontal collaboration between different authorities and agency's mentioned are competing interests between sectors and institutional levels (Norway, England, Germany, Romania, Slovenia), municipal stakeholders are involved in the management of water companies (England, Portugal), lack of monitoring data (Slovenia) or access to data (France, Germany), limited decision making powers or round table setting (Germany) and lack of staff (e.g. Germany (national level) and France) and citizen engagement (Portugal). |
| 2 | Appropriate scales within basin systems | Management instruments to support drinking water pollution control are used by all countries studied, yet different strategies have been opted for by individual countries to facilitate the use across levels and scales. England and Germany reports a high degree of advice and guidance for farmers at catchment and farm level for implementing the high level of regulation cascading from national and regional levels. Slovenia, Germany and Portugal stress a strong role for enforcement and cross-compliance. Other countries refer to the importance of monitoring and reporting and the development of programmes of measures of the WFD (e.g. France, Norway, Denmark). For Greece, a large variation was reported between management used for the different directives. In Norway regional drinking water authorities are invited to comment on municipal area planning.<br><br>The designation of safeguard zones around drinking water resources has been mentioned frequently as a successful instrument for protection. Other (mandatory) instruments mentioned are the use of monitoring to support the evidence base and the development of programmes to support a sustainable use of pesticides (education on use by farmers, Portugal, Norway, Germany, and 'Get Pelletwise' Campaign, UK) and manure (nitrate vulnerable zones, Greece).<br><br>The issue of scale is not regarded as a major issue for the countries studied, but rather the involvement of different sectors regarding agriculture and water quality (e.g. Germany and Greece).<br><br>River basin management committees (Slovenia, Netherlands, France and Denmark) and sub-basin committees (Norway) are reported as successful bridging mechanisms between different sectors but often lack a formal status. Similar examples are given for protection zones and nitrate vulnerable zones. Slovenia describes that the whole country has been designated as a nitrate vulnerable zone and issues are therefore all addressed at the national level. Germany reports a working group for SUD (Sustainable Use of Pesticides) implementation as a good example for bridging the administrative and other boundaries. In this group national and federal governments are participating.<br><br>In general, monitoring at the national and river basin scale meets the requirements set by the EU Directives. Cascading to regional, local |

| Principle | | Results from interviews |
|---|---|---|
| | | and farm level, monitoring becomes more sparse and there are differences between countries. Germany, Norway and Portugal for instance, report on the monitoring by farmers on use of fertilisation and N-budgeting. Romania sets rules for water quality monitoring by farmers. Other countries report on voluntary initiatives by farmers and/or water companies (Germany, Netherlands).<br><br>All countries stress the importance of environmental information, although socio-economic implications may play a major role in the decision making when stricter measures need to be implemented (Germany). The citizens engagement is used only limitedly so far in the process of decision making. In Germany, there is a citizen science project collecting and analysing nitrates from private and public groundwater extraction points and from surface waters. Other factors mentioned as relevant in the process of decision making are the overriding interest of the right to water (Slovenia) and the costs for providing good quality drinking water (France).<br><br>Frameworks for collaboration in transboundary river basins are in place, although the extent of collaboration differs.<br><br>A large variation between the level of collaboration and access to data has been reported for the various transboundary river basins. The large river basins in central Europe are to a great extent transboundary. Some countries have only few transboundary river basins, so this is of less concern to these countries.<br><br>There is a large variety between countries on their approaches towards public participation. Some countries report a well-developed participation at the national level (e.g. Northern Ireland, Germany) decreasing to lower levels. Other countries report that public participation primarily takes place at the river basin (Portugal), regional or local level (Denmark, Norway, England, Netherlands). In Norway there is public participation both at basin and sub-basin level, although this differs to some degree among basins/sub-basins. Farmers can participate as citizens or by NGOs (Norway and England). Options for online consultation are not always known to the public (France).<br><br>Only England reports a regular assessment of stakeholder engagement for drinking water. (The OFWAT has its own public and stakeholder groups who hold the Drinking Water Companies to account etc.). In Germany, drinking water quality is a relevant topic among a number of stakeholders. There exists a range of studies on the public costs of the drinking water pollution. |
| 3 | Policy coherence | The level of data and information sharing varies between countries. All countries studied report that data related to the WFD are open to the public. The way they are opened up varies, from open data platforms (England), websites (France) and river basin management plans (Slovenia). Data related to farming practices is much less commonly shared and often restricted to mandatory sharing (France), e.g. for licensing (Portugal).<br><br>Instruments reported for policy coherence relevant to horizontal collaboration in water quality governance include: multi-sectoral conferences (e.g. Germany, Greece, Norway), conferences for |

| Principle | | Results from interviews |
|---|---|---|
| | | transboundary river basins (Portugal, Romania), interdisciplinary workshops (Netherlands), inter-agency programs for specific issues (Northern Ireland, Portugal and Norway), information sharing with the agri-food-industry (Northern Ireland) and guidance on best practices (England). Some countries report horizontal communication as limited (e.g. France, Greece) and lack of clarity in responsibilities (water and agriculture).<br><br>Vertical coordination across different levels of governance is reported as limited for several countries for nitrates. Obstacles reported are data protection at farm level (Germany), disconnect between national policy and bottom-up initiatives (Netherlands, England), fragmentation of policy objectives (Norway), overlapping responsibilities (Greece), lack of funding for local collaboration (Greece, Slovenia). |
| 4 | Capacity | Authorities in most cases have the capacity to lead, monitor and evaluate the execution of policy plans. Lack of staff and finances has been reported frequently as an obstacle to carry out all responsibilities (e.g. Germany, especially on the legislative level, and England). A decrease of resources cascading from the national level to the regional/catchment level can be identified for some countries (e.g. Greece, Netherlands), but it can also be the other way round: lack of staff at the top, national level and sufficient staff at the bottom, e.g. for farm advice (Germany).<br><br>Several governance measures have been adopted by countries to build capacity to deliver water policy measures. Collaboration with the private sector (public authorities, private water companies and the agri-food industry) is reported. In England, the agency called Natural England (a non-departmental public body, sponsored by Defra) has teams of catchment advisors. This organisation enhances collaboration further by contracting private consultants to deliver water advice to farms. The Environment Agency makes Catchment Base Approach (CaBA) grants available to host catchment's partnerships. Some countries report the blocking role of GDPR (General Data Protection Regulation, EU/2016/679) for data sharing between local projects. |

*Table II.2 Results for OECD principles supporting the dimension 'Effectiveness' (OECD 2015).*

| Principle | | Results from interviews |
|---|---|---|
| 12 | Monitoring & Evaluation | All countries report that monitoring systems for water quality are in place. Yet the resolution of the monitoring locations may be different between countries and within countries between basins and regions. It is unclear whether the monitoring in place is adequate to monitor the effect of measures undertaken within the MAP. Monitoring groundwater quality in relation to certain measures in short term only works for shallow groundwater layers (see Lower Saxony Case, Textbox 2). Measuring the effect on deeper groundwater layer takes too long (groundwater travelling time of up to several decades). Moreover, the effect of denitrification will mask an effect of measures.<br><br>There are differences between countries as to whether programmes of measures are being adapted based on the monitoring results. Monitoring is used for identifying pressures (France, Norway), selection of the case study area (Germany) or most adequate measures (the Netherlands). Romania, England (not Northern Ireland) and Norway report that programmes of measures are being adapted based on monitoring results. |
| 10 | Stakeholder Engagement | Stakeholders involved include public authorities, water companies, farmers' organisations, industry associations, NGOs and experts, such as agricultural advisors and consultants. Several institutional levels are involved in the process of implementation. Interaction with stakeholders does not take place at all levels. Within the case studies, farmers and local citizens are being given the opportunity to be engaged. For some countries the stakeholder engagement set up for the case study is reported as a new way of collaboration (e.g. Slovenia).<br><br>Stakeholders in the MAPs have been engaged based on their interest in clean water, local knowledge, knowledge on best practices (e.g. catchment advisors (England, Portugal)), sources of pollution (e.g. Slovenia, Netherlands, Germany, Denmark, Norway), established networks (Northern Ireland, Germany, Portugal) and the means and power to act (e.g. Slovenia, Romania, Denmark).<br><br>Focus of the case studies is on farming and water quality, so this directed who was invited and who was not. Several countries report that any actor who wants to participate can, yet when voluntary measures are at stake, not all farmers want to participate. Norway reports that private commercial actors have not been included yet in the river basin committee because of their primarily economic focus. Yet, the importance of their role is acknowledged in the process, so dialogue are frequent, and other meeting arenas exist. Other motivations for restrictions are group size (to allow discussions) and costs (advisors). England reports that some stakeholders are reluctant to speak if the regulator is also part of the stakeholder group.<br><br>Some countries report that different authorities from different institutional levels participate in the MAP (e.g. Germany, Norway, France). Others report a disconnect between the different levels (e.g. Greece) or a single layer governance approach (Slovenia). This may also differ for different case studies and regions (e.g. Germany). |

| | | |
|---|---|---|
| | | Not all stakeholders have been asked how they value the engagement process. But for those who have been asked, the stakeholders are positive. Germany (parts of Lower Saxony) indicates that all of them still participate, the Netherlands report that farmers feel that they are taken seriously. Top down decision making is regarded as a serious draw back from stakeholder engagement (e.g. Greece, France, Slovenia). Northern Ireland observes that the importance of clean drinking water makes it relatively easy to engage stakeholders. |
| 11 | Trade-offs across users, rural and urban areas, and generations | The role of trade-offs of costs, benefits and distributional effects of various alternatives in agreed service level decisions in the case studies is dependent on how many of the measures that need to be taken are legally based. Portugal for instance, with a strong legal base for measures that need to be taken, uses the 'polluter pays' principle, that has been anchored within the legal framework. For other case studies, that rely more on voluntary based measures, a balanced trade-off between costs and benefits for farmers, is much more prominent in the selection of measures (e.g. Denmark, Netherlands, Northern Ireland and Norway). |
| 9 | Transparency and integrity in decision-making | Conflict prevention and resolution is addressed in different ways. Northern Ireland refers to the communication plan in The Rivers Trust for the Source To Tap project that as a means, Germany (Lower Saxony) to Round Tables for Agriculture and Water Protection and the Netherlands to the agricultural advisor as arbiter. Legal procedures are rarely used for conflict resolution regarding nitrate and pesticide pollution e.g. due to difficulties related to control and proof of an offence (Germany).<br><br>Countries report as mechanisms for conflict resolution arbiter role of the municipal agricultural advisor and MAP coordinator (Norway, Netherlands), cross-compliance (Portugal), financial incentives (Germany: farmer-waterworks cooperation), compensation and land consolidation (Denmark), agricultural support (France, Germany), public consultation and the role of civil initiative (Slovenia).<br><br>Public consultation (Slovenia), baseline regulation (Portugal) and voluntary agreements and compensation (Denmark) have been reported as being used for conflict resolution. |
| 7 | Regulatory frameworks in place and enforced | Regulatory frameworks and enforcement play an important role in achieving jointly agreed policy objectives, although there are different views regarding the right balance between voluntary and legal based measures for these objectives. Some countries rely primarily on legal based measures (e.g. Portugal, Germany) and a strong role for enforcement, other countries are more committed to voluntary measures and enforcement (e.g. Netherlands, France), or there is a mix of both types of instruments (e.g. Denmark and Norway). Economic incentives, such as compensation, play an important role for both voluntary and mandatory measures (e.g. Denmark, Germany and Norway). Norway refers to the information provided by the municipal agricultural advisor, the MAP coordinator and research projects as an incentive, for instance for cases where there is disagreement on the cause of a problem. |
| 5 | Data & Information | Most countries studied report that measures are based on both knowledge of issues, possible interventions and possibilities of the legal framework. Especially for the latter, the link to the legal framework differs for countries. Several countries rely on voluntary |

| | | |
|---|---|---|
| | | based measures where the link is less explicitly on nitrate and pesticides reduction, but may be driven by economic motivations as well. Knowledge is based on scientific studies and best practices in other areas. Agricultural advisors play an important role. Little notification has been made in the responses of the use of learning by doing (adaptive capacity) to improve the effectiveness of interventions. |

# ANNEX III CASE STUDY INFORMATION

## III.1 ISLAND TUNØ (DENMARK)

The Danish drinking water supply is entirely based on groundwater, and the government's official position is that drinking water should be based on groundwater with a good quality, which only needs simple treatment as e.g. aeration and filtration before it is distributed to the consumers.

The Danish water supply structure is highly decentralized with approximately 2,600 public waterworks supply five million inhabitants, while the remaining approximately 0.4 million inhabitants use water from approximately 70,000 private wells (Nature Agency 2012). Public water supply is the main source of drinking water, bottled water consumption being amongst the lowest in the EU, with only one fifth of the EU average (UNESDA 2014).

Approximately, 63% of the Danish land area is agriculture with intensive use of fertilizers, manure and pesticides. This might be a challenge to some water suppliers, if they abstract groundwater from vulnerable, unprotected or shallow aquifers. This is especially the case for many private wells.

Numerous waterworks and wells have been closed because of nitrate pollution (Danish Economic Councils, 2015), and approximately 17% of the Danish area has been classified as nitrate vulnerable groundwater abstraction areas (Ministry of Environment and Food of Denmark, 2017).

Danish groundwater protection has a high priority and is carried out through 3 principal initiatives:

1. National level: general agricultural regulation
2. Municipality level: local action plans based on detailed groundwater mapping
3. Well level: Extra protection close to abstraction wells (25 m's protection zones, BNBO)

Groundwater protection on Tunø was the first of its kind in Danish water supply history where a project has succeeded to protect and restore groundwater against nitrate leaching. The project started in 1986. The protection is based on the use of protection zones in the capture zone of the abstraction wells. The protection involved comprehensive and systematic monitoring to determine the effects on the groundwater quality.The Tunø case is a successful example of groundwater protection on a small island with one small waterworks where the aquifer is vulnerable to nitrate pollution and salt-water intrusion. The case will be used as a "lesson learned" and the following objectives has been identified with Tunø :

- How to achieve farmer commitment to solve drinking water problems.
- How to sustain a long-term project under changing administrative structures (long-term project management > 20 years).
- How to get measures accepted by farmers (including time to accept).
- How is farming practice affecting nitrate in groundwater.
- Is the current groundwater protection strategy the most cost-effective?

From the Tunø case, there are many qualitative and quantitative data available on agricultural practices, soil solution quality, hydrology, hydrogeology, groundwater and drinking water chemistry

for an extensive period.

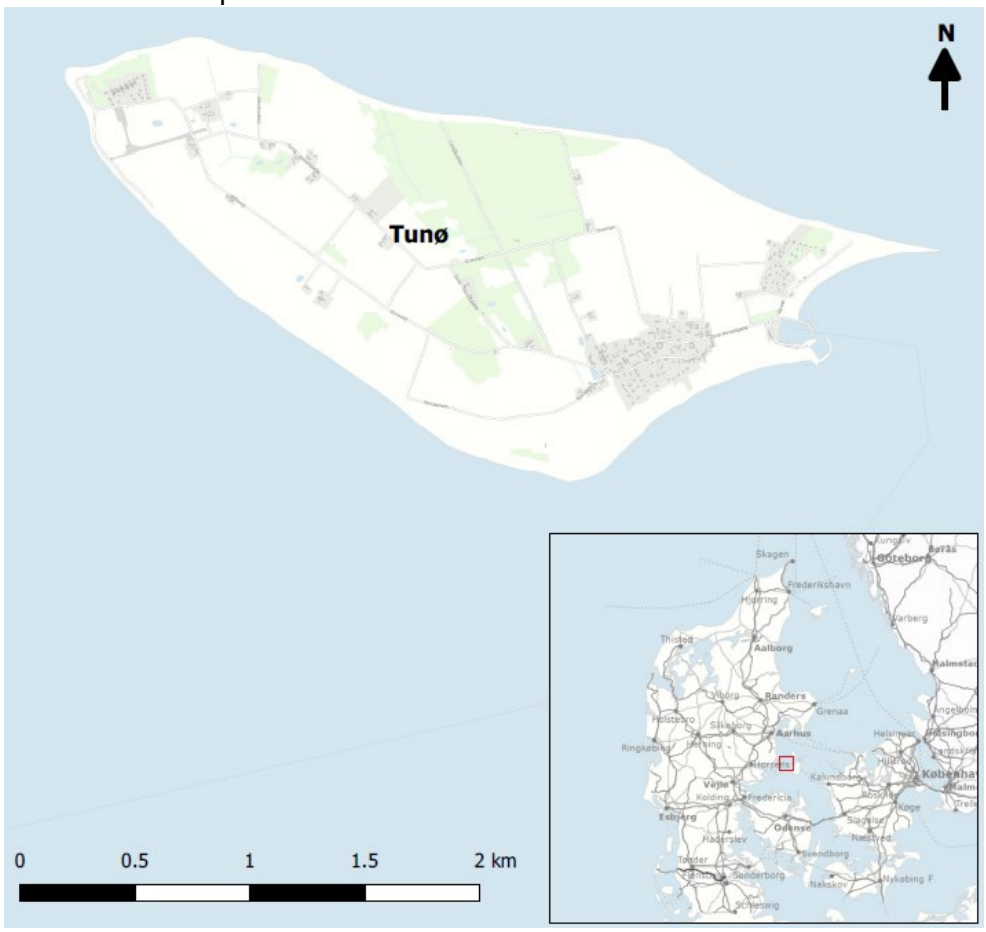


*Figure III.1 Location map island Tunø, case study area (Denmark).*

There used to be a MAP in this area, but because the problem was solved, the MAP is no longer active. The MAP consisted of the local water works, two local farmers, the municipality, the local agricultural adviser, and the former county. In FAIRWAY, the development and structure of the former MAP over time will be analyzed. It will be considered if a new MAP should be established.

See also Case studies (fairway-project.eu).

## III.2 AALBORG (DENMARK)

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National Danish legislation aim to protect groundwater resources and surface waters from the effect of N loss to the environment, and Denmark has introduced several political action plans since 1985.

A national groundwater mapping program has been carried out since 1998 with the principal aim of mapping groundwater vulnerability in Denmark in order to ensure optimal protection of present and future drinking-water resources. It involves approximately 40% of the total Danish land area classified as particularly valuable for groundwater abstraction. Local groundwater protection action plans are carried out by the municipalities in order to protect drinking water resources based on the findings from the national groundwater mapping program.

The Aalborg area is one of the most vulnerable areas in Denmark in regard to nitrate leaching and pollution of the groundwater. A monitoring program is established and many observations and quantitative data are available for a long period. The data shows that the water contains variable amounts of nitrate and traces of some pesticides.

The Aalborg case is a pilot area where focus is on both nitrate and pesticides. The following objectives have been identified:

- Improvement of the collaboration between farmers and the waterworks on groundwater protection. This will be done by e.g. improving the dialog on the scientific basis for groundwater protection, and creating common understanding of the actual problems. The existing MAP will eventually be further developed and extended to meet these objectives.
- Analyses of possibilities of integrated agriculture production and drinking water production. Are current agricultural practices applicable to secure good drinking water? Can good farming practices be further developed?
- Analyses of afforestation and exchange of land as measures for groundwater protection.
- Analyses of challenges for small waterworks and private wells.
- Involvement of citizens and farmers in monitoring.


*Figure III.2 Location map Aalborg case study area (Denmark).*

For the Aalborg case study, there are established boards which should be considered as starting points for the Fairway MAP. A “Groundwater board (Grundvandsrådet)” exists maintained at the municipality of Aalborg. The Groundwater board consists of approximately 20 members with different interests as e.g. agriculture, environment, nature, forest, groundwater etc. A drinking water collaboration board called “Water Collaboration Aalborg” also exists within the municipality of Aalborg. Water Collaboration Aalborg is responsible for negotiation of agreements on groundwater protection with the farmers as part of the local action plans for drinking water protection.

The FAIRWAY MAP for Aalborg includes the municipality of Aalborg, Aalborg Vand A/S (a large public supply company), Water Collaboration Aalborg and local agricultural advisory companies (AgriNord, Økologisk landsforening) as well as the local farmers and private waterworks in the case study site.

See also Case studies (fairway-project.eu).

## III.3 ANGLIAN WATER (ENGLAND)

Compliance with drinking water quality standards in the UK is the responsibility of privatised water companies monitored by the Drinking Water Inspectorate. Anglian Water (AW) is geographically the largest of 10 water supply and treatment companies in England and Wales, supplying drinking water to over 4.2 million customers covering 27,500 km2. With almost 260 individual catchments, supply is split equally between ground and surface water with 9 reservoirs. The area includes the area of fastest population growth (predicted 34% growth in households by 2031). Land Use is

predominantly arable with a wide range of soil types from blowing course sand to Grade 1 silt to heavy clay. With high quality farmland, the area is one of the most important and productive in the UK. The Case Study involves several discrete areas of the Anglian Water region.

Anglian Water (AW) has funded a number of Catchment Officers who are responsible for reducing the amount of pesticides reaching water treatment works. Since 2015 the Catchment Officers have adopted a range of approaches to engage with farmers to achieve this objective with a particular focus on minimising the use of metaldehyde. This Case Study focuses on studying the social science lessons behind 2 approaches to reducing on-farm pesticide use, collecting comparable data in a third control area with metaldehyde challenges (Cringle Brook catchment, (42 sq. km.)); then testing a third approach of 'new network engagement' measures in the Cringle Brook and sharing /testing BMPs from other Case Studies.

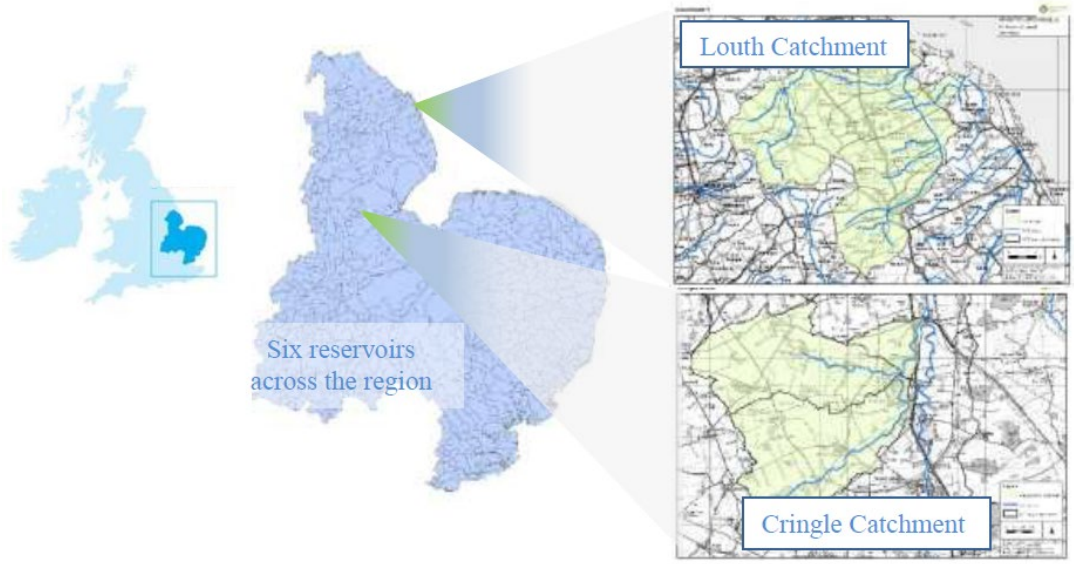


*Figure III.3 Location map Anglian Water case study areas (England).*

There is a multi actor platform in place but it is very informal and the participants not considering themselves to be a MAP. We may need to formalize more than one MAP due to the dispersed nature of the sites.

In the Network Engagement area there is a very informal MAP of local stakeholders such as agronomists, water company, National Farmers Union who are engaged in information sharing with the Anglian Water adviser in that area. Similarly, in the Ecosystem Service areas (6 discrete and scattered reservoirs) the AW advisers have created informal groups that have the potential to become MAPs. In the Cringle Brook area there is no MAP yet and this will be a task to undertake in the H2020 funding period, setting up a MAP. The current informal proposal with Anglian Water is to form a MAP in the Cringle control area including wider stakeholders than currently tried (and so including non farming community and non local stakeholders). We also plan to develop a more formal MAP for the Network Engagement area if acceptable and engage more widely. We will be assessing how acceptable this is with the farming community.

We plan to involve national stakeholders as a means of dispersing best practice.

See also Case studies (fairway-project.eu).

## III.4 LA VOULZIE (FRANCE)

The case study concerns the Voulzie basin which is part of the Champigny limestones aquifer located in Seine-et-Marne, 70 km south-east of Paris. This aquifer is the main groundwater resource in Ile-de-France and very important for drinking water supply of Paris.

Eau de Paris is a public organisation in charge of managing water resources for Paris. Eau de Paris supplies 176 $Mm^3$/y to 3 M people. La Voulzie basin contributes to 10% of Eau de Paris ressources. As these resources are located in an area of intensive agriculture, one the main challenge of Eau de Paris is the protection of water resources by including local needs of territories. For that reason, Eau de Paris develop a privileged relationship with associations and representatives of farming. Eau de Paris is particularly active in promoting agri-environment measures to reduce nitrate and pesticides.

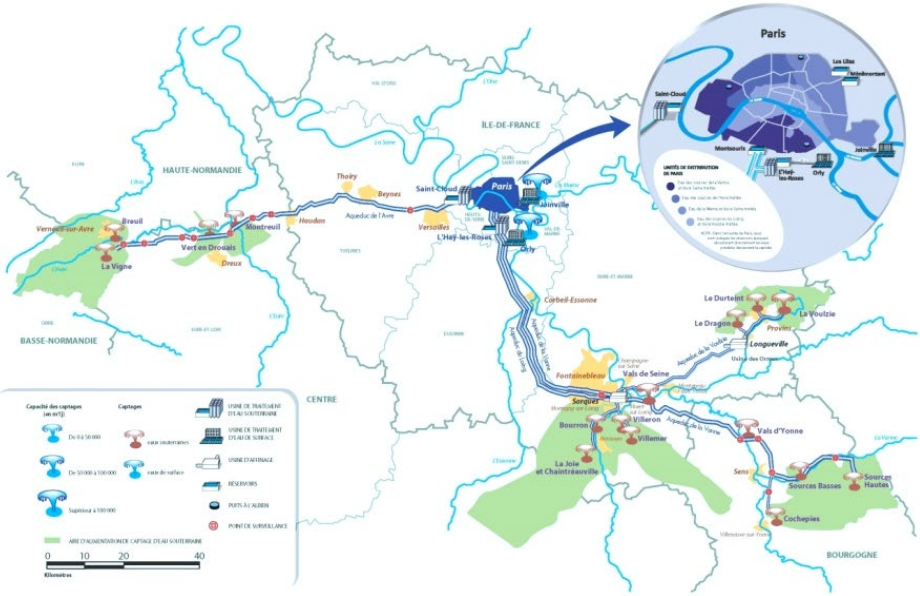


*Figure III.4 Location map La Voulzie case study area (France).*

Since 1990, Eau de Paris leads actions to reduce nitrates pressure on the basin and since 2007 to reduce pesticides pressure. Objective:

- 50 mg $NO_3$/l in groundwater (springs);
- 0,1 µg/l by pesticides in groundwater (springs).

Targets for agricultural management:

- Reduce transfer of nitrates;
- Reduce the use of pesticides.

Eau de Paris promotes agricultural practice changes via agri-environment measures organised together with local farmers; and closely follows their application and their impact on water quality in order to identify agronomic actions or land use having limited impact on water quality.

The good cooperation between stakeholders on pesticides and fertilisers management practices capable of reducing diffuse pollution in La Voulzie basin is illustrated by:

- The agri-environmental measures taken: they slightly changed over time but includes: conservation of biodiversity, fertilization reduction, pesticides reduction (herbicide and others pesticides: from 1000 ha covered in 2007 to 4000 ha in 2012.
- The farmer involvement: In addition to the agri-environmental measures for which ones the farmers receives monetary compensation, farmers also develop individual and voluntary initiatives showing their great involvement (e.g agroforestery managed plots).
- The intense pesticide and fertilizer monitoring.

A platform  for engagement in the case study, is already in place. Engagement in this platform from Eau de Paris, about 100 farmers and rural communities. Eau de Paris is a big water company and uses water resources of this basin for drinking water supply of Paris. This is not always well accepted by local authorities and farmers.

MAP-challenge:

- A better cooperation between stakeholders (citizens, farmers, local authorities…) and tools that enable a right balance between economic activity and preservation of water resources.

See also Case studies (fairway-project.eu).

## III.5 LOWER SAXONY (GERMANY)

The case study area covers the German federal state of Lower Saxony. The northwestern province of Lower Saxony “Süd-Oldenburg” (districts Cloppenburg, Vechta and Oldenburg) is characterized by very-intensive pig and poultry farming, biogas plants and very high farmland (leasing) prices. Consequently, area-based surplus of farm manure is high. Since in the northwestern region also sandy soils dominate with small water retention capacity, nutrient leaching to the groundwater bodies is potentially high as well.

In contrast, the southeastern province of Lower Saxony (e.g. the provinces Braunschweig and Northeim) is predominantly specialized on crop production. Soil conditions are diverse (sandy to clayey). Some farms make use of biogas residues, sewage sludge and compost; however, the area-based amount of organic fertilizers applied ranges on a low level.

Since in Germany local water supply companies safeguard drinking water quality, they have very high interest to meet the legal regulations according to the German Ordinance on Potable Water (TrinkwV 2016). In the past, many attempts have been made to shape agricultural management in a way that drinking water resources are less affected.

In this context, the federal chamber of agriculture (Landwirtschaftskammer Niedersachsen), which is the public advisory authority for agricultural purposes, has initiated a program, which aims at closing nutrient cycles on supra-regional scale. The joint project “Farm manure management” examines the (potential) export of farm manure from surplus regions to arable farming regions. Consequently, the case study area consist of two provinces within the region (see Figure III.5).

The case objective is to release groundwater pollution in the northwestern districts by supra-regional transport of farm manure (joint project Farm manure management). In a first step, the potential volume of farm manure prone to export is estimated. However, the imported farm manure should not result in an aggravated situation in the farm manure receiving districts (southeast). Therefore, the second step is the identification of factors, which further decrease this volume.

The case study consists of three parts:

1. Farm manure exporting farms in the northwest.

   Farmers in the northwest receive professional advice in a way that they can meet the legal requirements with the help of farm manure export. By that, also pressure on the environment (nitrate, pesticides, residues of veterinary drugs, etc.) is relieved. Issues concerning animal feeding, farm manure processing, administrative constraints and costs are considered.

2. The transport operation itself and ways to certify the quality of the individual substrates.

   The goal is to develop a compulsory quality management system with impartial certification and yearly monitoring. A crucial aspect is the reliable analysis of nutrient contents in the farm manure. Thus, methods for fast analysis of nutrients are examined (e.g. NIRS) and most feasible ones are identified. Furthermore, traceability of farm manure exports and standardized documentation (e.g. with the help of GPS and barcodes) is targeted.

3. The farm manure receiving farms in the southeast.

   With the help of professional advice, it is carefully examined how farms can most efficiently make use of imported farm manure. Also factors other than economic considerations (so-called ‘soft factors’), limiting the willingness of farmers to import farm manure, are regarded.

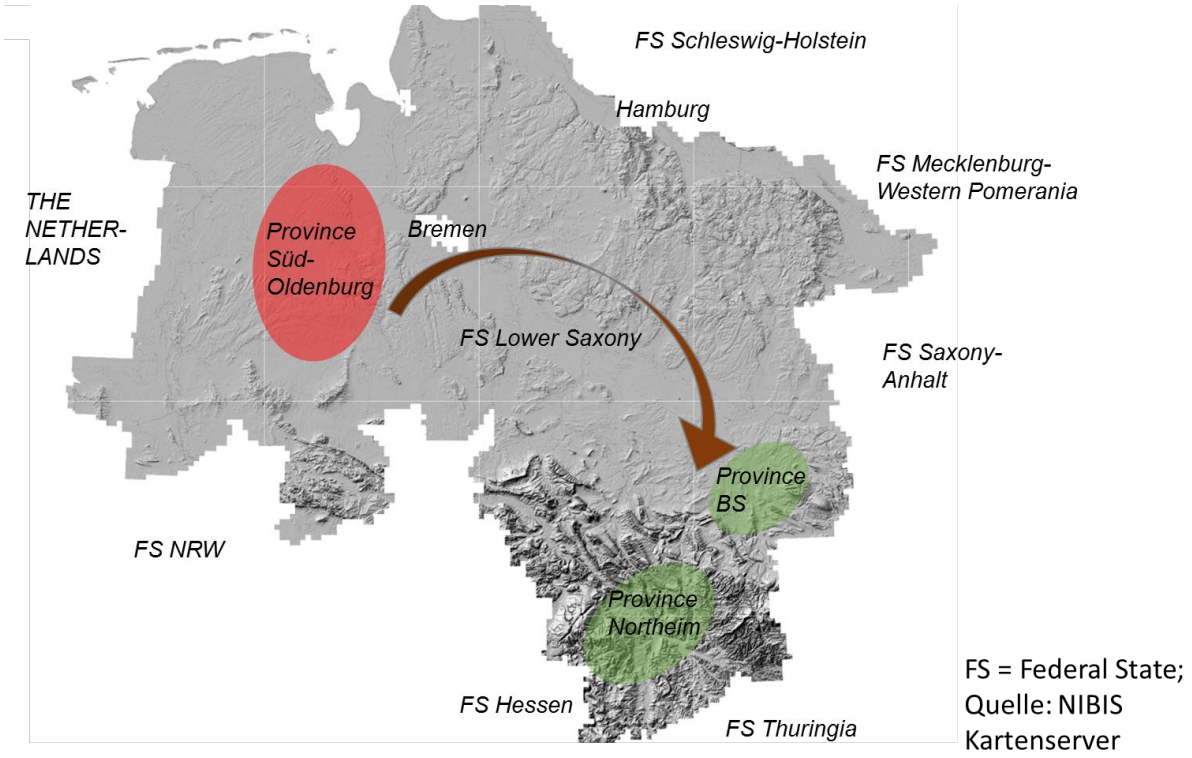


*Figure III.5 Location map Lower Saxony case study area (Germany).*

Measures to meet objectives in the northwest region:

- Feeding regime.
- Manure storage capacity in order to make efficient use of organic fertilizers.
- Farm manure export from northwestern provinces (pig, poultry, biogas) to southeastern provinces (arable).
- Manure processing (e. g composting of pig slurry).
- Quality control and documentation.

Measures to meet objectives in the southeast region:

- Substitution potential of mineral fertilizers estimated.
- Farm-specific fertilization plans (IT-based), combining agronomic, logistic and economic data.
- Calculated nutrient balances of southeastern farms to help them decide whether they still meet the legal standards if they decide to import farm manure.
- On-farm observations and measures (soil and plant) during the growing period.
- Assessment of economic effects of the use of farm manure (substitution of mineral fertilizers).
- Standardization of quality of farm manure and the promotion of well-adjusted distribution techniques.
- Effects of measures on soil and water in the southeast by monitoring the nitrate concentration in the soil.

On a national scope, laws on agricultural management (esp. fertilization) and water and nature conservation exist. The federal states have to translate national targets to their own laws and have to make sure that these are met. The ministries of agriculture (ML) and nature conservation (MU) of the federal state of Lower Saxony direct these tasks to specialized public institutions. For the case study, the relevant authorities are the chamber of agriculture (LWK), the authority for nature protection (NLWKN) and the authority for mining, energy and geology (LBEG). On district-scale, monitoring takes place by the local water authorities (Untere Wasserbehörden). Furthermore, water supply companies, which have to guarantee drinking water quality, are also major players. Farmers participate on a voluntary basis.

There is an existing Multi Actor Platform, however, this platform does not include farmers themselves. In districts where nitrate concentrations in the groundwater stagnate on high levels, so called “round-table discussions” are recently being initiated (both in northwestern and southeastern districts). Participants are representatives of district authorities for water and agriculture and local advisory services. A district representative of farmers is the official promoter of the meeting. However, other farmers do not participate. Since the round-table discussions are recently being initiated, more detailed information about concrete constraints and opportunities are therefore expected in the near future.

See also Case studies (fairway-project.eu).

## III.6 AXIOS RIVER (GREECE)

The Region is located in Central North Greece. It extends from the North borders of Greece with FYROM down to the estuary of River Axios. River Axios is a transboundary river, originating in the Balkan peninsula and flowing into Greece to form a delta, right next to the city of Thessaloniki,

which is the second most populated city on Greece (1.5 million people). The estuary has been characterized as an area protected by “Natura” network, for its flaura and fauna diversity and because it serves as a breeding ground for migrating birds. At the delta area, there are many aquacultural activities including fish and mussel breeding areas.

The Axios river basin covers 1,636 km$^2$ area. The river springs from the mountainous area between Albania and FYROM with a total catchment area 22,250 km$^2$ and only a small part of it (2,513 km$^2$) belongs to a Greek territory. The river flow, arriving from FYROM to the Greek area, depends on the FYROM management policy. Axios is the most important transboundary river in Greece, especially because of his water use for irrigation. In the area rivers Loudias, Gallikos and Aliakmonas also participate in the water supply.

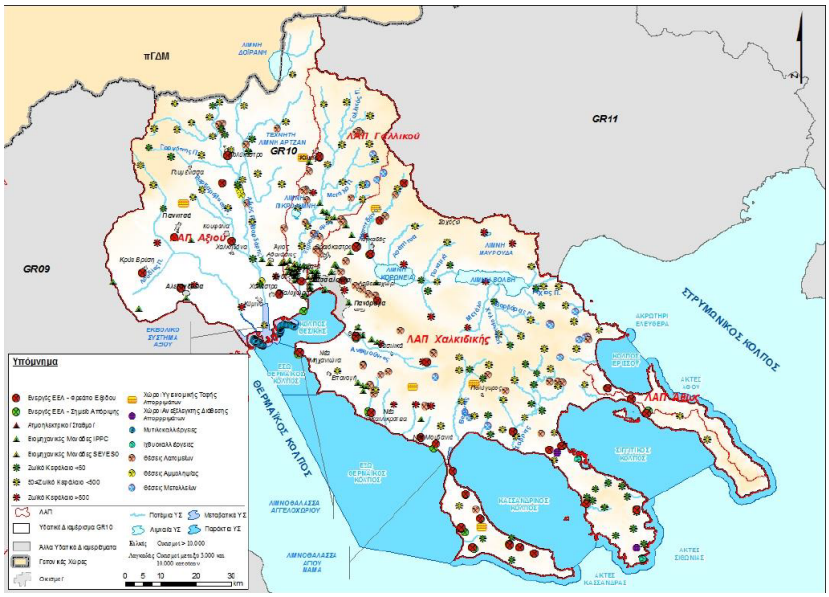


*Figure III.6 Location map Axios river case study area (Greece).*

Groundwater has been proven to be contaminated by heavy metals (Mn, Ni, As, Cr ), F, B, $NO_3$ and phosphates. Also a wide range of pesticides have been detected in various concentrations due to the extensive agricultural activities and the irrational use by farmers. Objective:

- 50 mg $NO_3$/l in the upper phreatic groundwater below agricultural area;
- 0,1 μg/l pesticides in the upper phreatic groundwater below agricultural area.

Case study aims to monitor, register and statistically analyse pressures and pollution indicators. Monitor farmer’s practices according to specific cultivation activities. Quantify applied fertilisers and pesticide use. Take into consideration livestock production and source identification of pesticides. Design and implement activities related to maximization of best agricultural practices.

The farmers grow different crops (grass, potatoes, tomatoes, barley, sugar beets, vegetables, maize and wheat). Main measures include land use change, changing nitrogen fertilization and groundwater use regulation. Also application of less manure or no manure application under certain circumstances. Also choice of pesticides with less environmental impact, lower doses or dosing at specific periods of plant life. Also registration of pesticide use could be implemented.

How to help farmers participate: demonstrate on the case study level of new types of techniques, inform and cooperate with the market that sells pesticides or fertilizers.

The Ministry of Development had launched a project to pass around information of the stakeholders for these system and tools as basic administrative tools for the development and updates of the water management plans in a river basin for the implementation of the WFD. A minimization and rationalization of pesticide use through state programs and other national activities related to agricultural development, was agreed.

The case study includes the development of a multi-actor approach, including water companies, farmers advice company, regional government, farmers organizations, market (fertilizer and pesticides). Main stakeholders are DEYA Kilkis (administration body for water management in the area of Kilkis), Municipalities of Kilkis, Pella and Imathia, companies related to fruit cultivation and juice production, agricultural unions of Axios river Basin. The history of collaboration between these actors is not clear.

The MAP should involve farmer's needs and inform them on the effect of their practices on water monitoring by including goals, water monitoring, consumers of water, and help the participation in stakeholder meetings.We want the MAP to be a registry database of practices and needs, and to give farmers solutions and not only regulations and implementation through punishment. In the case study the stakeholders take part in analysis and evaluation of costs and benefits.

See also Case studies (fairway-project.eu).

## III.7 PROVINCE OF OVERIJSSEL (NETHERLANDS)

Groundwater in the Netherlands is a major resource for drinking water. In the province of Overijssel it is the only source for drinking water. As such it must be carefully monitored and managed. The province is responsible for protection of groundwater used for drinking water purposes.

Evaluation of the EU Water Framework Directive (EU-WFD) showed that protection of this valuable resource needs improvement. The Drinking Water Protection File identifies necessary measures needed per water abstraction site. The Protection File is part of the Dutch national EU-WFD implementation strategy, intended to improve the protection level of groundwater resources. It consists of a national top-down framework and a regional bottom-up process, which respectively enforces commitment and enhances stakeholder awareness regarding risks and actions needed regarding the identification and implementation of measures enhancing the protection level of groundwater resources. The case study consists of the recharge area of 5 vulnerable drinking water abstractions in the province of Overijssel, the Netherlands.

Since 2011, the province of Overijssel and the drinking water company Vitens together with Wageningen University, Countus, Stimuland and Royal HaskoningDHV support dairy farmers to improve their mineral management in the recharge areas of five vulnerable drinking water abstractions.

Objective:

- 50 mg$NO_3$/l in the upper phreatic groundwater below agricultural area;
- 0,1 µg/l pesticides in the upper phreatic groundwater below agricultural area.

Targets for agricultural management:

- N-soil surplus of max. 100 kgN/ha calculated by the Annual Nutrient Cycle Assessment (ANCA);

- Max. 100 Environmental Impact Points (EIP) of individual pesticides and max 500 EIP for the total of all pesticides used.

Measures identified, discussed and/or -implemented in the case study area:

1. Increase manure storage capacity;
2. Optimizing grazing – reduction of the grazing period in autumn;
3. No manure application on maize when maize is grown in a rotation after grass land;
4. Application of less manure on the part of the parcel where the machines have to make a turn;
5. Sowing grass in maize after maize is knee-high to increase the effectivity of grass as winter cover crop;
6. Parcel-specific application of manure, taking into account that not every parcel has the average productivity of the farm;
7. 'Wiedeggen': Mechanical weed control in grass;
8. Mechanical weed control in maize;
9. Crop rotation;
10. More efficient feeding of cows – and evaluation of the number of young cattle per cow to be held on the farm.

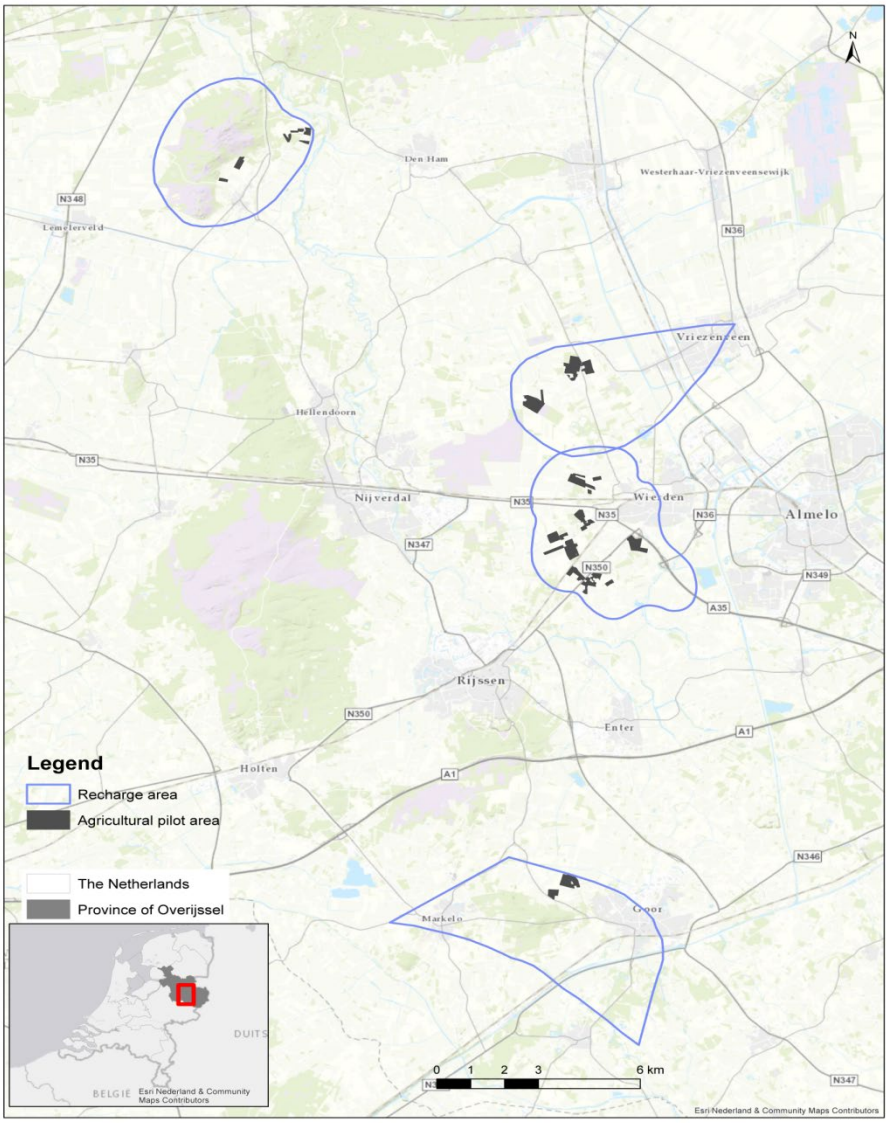


*Figure III.7 Location map case study areas in province of Overijssel (Netherlands).*

The province, water company and farmers are in the centre of the MAP for the case study areas, supported by the consultants & researchers running the project. In addition, we inform and engage other stakeholders involved, not having a direct interest as f.i. land owner / user: agricultural contractors, other agricultural advisors (for manure, fertilizer, …), banks.

Platforms:

- Study group meetings, in which farmers work together with agricultural advisors and province & water company are only present 'to show their interest';
- Evaluation meetings in which all stakeholders have their 'official' role, representing their 'official' responsibility (province) or interest (water company);
- Regional platform: from 2017 on, the pilot will be part of a regional initiative in the province of Overijssel, consisting of 500 farmers, and financed by the province, 3 water boards, 1 drinking water company, bank, 2 agricultural firms and the EU.

The role of the province and water company is not easy. They are viewed by the farmers as responsible stakeholders. If they join general meetings frequently, the farmers conclude that 'a lot of money is spend on overhead'. If they don't join general meetings frequently, the farmers conclude that 'they have to implement a lot of difficult measures, but province & water company don't even take the effort to share their enthusiasm'.

The challenge of the coming period is to extend the current MAP in such a way that the MAP contributes to a continuation of the measures. We will explore 'social enforcement' of the measures by merging the pilot into a bigger regional initiative. We will also explore 'financial instruments' by initiating a discussion with banks (part of the regional initiative) willing to stimulate 'sustainable agriculture'.

See also Case studies (fairway-project.eu).

## III.8 PROVINCE OF NOORD-BRABANT (NETHERLANDS)

The case study region is located in the south of The Netherlands, in the province of Noord-Brabant. This province has an area of 4.919 km² and it is populated by 2,48 million inhabitants. The northern border follows the Meuse (Maas) river westward to its mouth in the Hollands Diep strait, part of the Rhine–Meuse–Scheldt Delta.

The province of Noord-Brabant is important for the Dutch drinking water supply. Drinking water is produced from ground water that is abstracted from 39 locations in the province. The annual drinking water production is 180 million $m^3$. http://www.brabantwater.nl/. In addition the provincie of Noord-Brabant is part of the catchment area of the river Meuse. The surface water of the Meuse is a drinking water resource for 3 million people in the western part of the Netherlands.

The abstraction sites for drinking water in Noord-Brabant vary in depth and vulnerability. The shallow and most vulnerable sites are surrounded by ground water protection areas. Land use in these areas is a mixture of agriculture, nature and urban area.

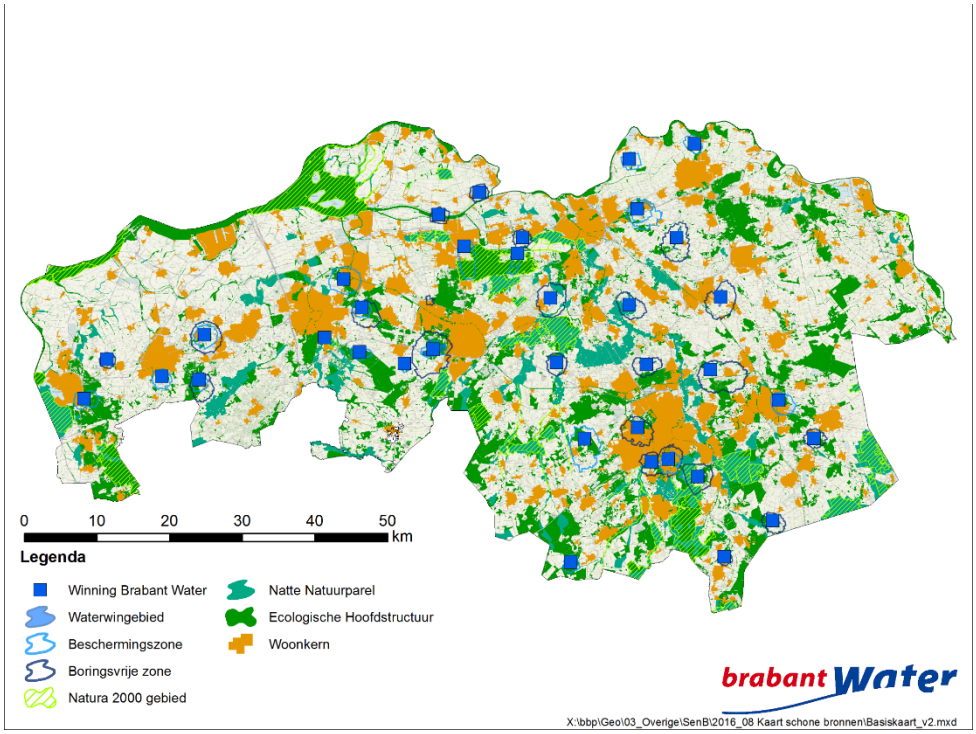


*Figure III.8 Location map case study areas in province of Overijssel (Netherlands).*

Main objective of the case study is to reduce the use of pesticides that have could affect the quality of drinking water sources in Noord-Brabant. To this end is a monitoring program is carried out by Brabant Water and the province to identify threats to the groundwater and surface water (monitoring of tap water, raw water and groundwater/surface water). There is also guidance and support for farmers (since a number of years) to mitigate leaching of pesticides. Furthermore, both municipalities and civilians are supported to reduce the use of pesticides. Over 300 farmers and contractors are participating. These farmers and contractors are responsible for more than 4.000 ha of agricultural land, which cover 85% of the total agricultural land in the groundwater protection zones.

The farmers grow different crops like grass, maize, potatoes, sugar beets, trees and vegetables. A simple contract between farmers that participate in the case study and the province has been put in place. This contract includes an agreement on reduced use of pesticides. The farmers take measures and (try to) implement innovations and new techniques (new spraying techniques, low dose systems, mechanical weeding, warning systems, GPS). They choose pesticides with low environmental impact using the environmental yardstick for pesticides (www.milieumeetlat.nl/en/home.html) . The farmers also register their pesticide use.

Three key factors are used to stimulate participation of all famers in this approach:

1. Uptake of new techniques: Almost every farmer is interested in techniques. Demonstrating new techiques and supporting farmers in buying new techniques is a key factor.
2. Cooperation with the advisers that sell pesticides and minerals to the farmers: When the advice of these intermediates is in line with the goals of the drinking water company, the large group of farmers can be reached.
3. Cooperation with the farmers contractors and supermarkets. This cooperation takes place with the contractors Bakker Barendrecht and Nedato, contractors for Ahold supermarket. When the demand of the supermarket is in line with the goals of the drinking water company, the large group of farmers can be reached.

There is also urban involvement in the case study. Municipalities reduce their pesticide use to zero on hard surfaces and to low use in parks, sport pitches and golf areas.

The case study involves a multi-actor approach, including farmers advice company, regional government, waterboards, drinking water company, farmers organisation, pesticide industry and farmers contractors. This includes the following parties:

- Brabant Water (drinking water company)
- Province of Brabant (regional authority)
- ZLTO (agricultural organisation)
- Cumela (organisation for agricultural contractors)
- CLM (advisory service for agriculture and water quality)
- Delphy (crop advisors)
- Water Authorities (Dommel, Brabantse Delta, Aa en Maas, Rivierenland)
- 18 municipalities

These stakeholders together discuss goals, monitoring, measurements for both inside and outside agriculture and evaluate them in stakeholder meetings. In the case study the stakeholders take part in analysis and evaluation of costs and benefits, in evaluation of the stability and sustainability of the current groundwater protection strategy, and in stimulation of the involvement of supermarkets. Furthermore, new stakeholders including supermarkets will be involved.

See also Case studies (fairway-project.eu).

## III.9 DERG CATCHMENT (NORTHERN IRELAND - IRELAND)

The Derg catchment (Area 552 $km^2$), is located in the north west of Ireland, spanning the border between Northern Ireland (NI) and the Republic of Ireland (RoI).

The catchment is situated within a Temperate Oceanic climate zone, with average rainfall of 1,000 - 1,400 mm/yr and a mean annual temperature of $9^0$ C. The catchment is underlain by igneous and metamorphic bedrock, overlain by deposits of glacial till and fluvioglacial material. Groundwater productivity is relatively low, limited to the weathered near-surface zone and only for limited individual use. In the upper western reaches of the catchment land use is predominantly coniferous plantation and bogland with low intensity farming on poor pasture land. In the lower reaches intensification of land use for agricultural purposes is more prevalent with improved grasslands and complex cultivation patterns.

Raw drinking water is abstracted from surface water on the River Derg, to serve the population of Derry City and Strabane District Council. Northern Ireland Water (NIWater) is the sole provider of drinking water in Northern Ireland, supplying 560 ML of clean water a day for almost 1.8 million people.

NIWater and Northern Ireland Environmental Agency (NIEA) and the Environmental Protection Agency (EPA) implemented a comprehensive monitoring program of drinking water quality in the catchment. The Derg WTW and Supply System Risk Assessment carried out by NIWater 2015 identified two main threats to raw drinking water in the catchment.

1. MCPA (herbicide) arising from the spraying of rushes (Juncus) on agricultural land. The need to remove rushes from agricultural land is being driven by farmers' concerns over eligible land for the EU single farm payment. Increase in rush cover is being attributed to prolonged saturation of soil, lower stocking rates and lowered soil pH).

2. Colour/turbidity arising from peaty soils and eroded sediment from both forestry and agricultural land. Chlorination reactions with dissolved organic carbon (DOC) during the drinking water treatment process results in the production of toxic trihalomethanes.

Starting in March 2017, the INTERREG VA funded 'SourcetoTap' (StT) project aimed at reducing the impact of landuse on drinking water in the Derg River Catchment. The StT project addresses both forestry and agriculture, however the main focus is on mitigating loss of MCPA, sediment and DOC from agricultural land in the catchment.

During the 5 year project, a farm incentive scheme is being implemented on a cross border basis and will incentivise farmers to take-up measures to mitigate MCPA and colour/turbidity arising from farms in the Derg Catchment. The scheme is delivered by dedicated TRT catchment officers who are responsible for community engagement and knowledge exchange within the catchment.

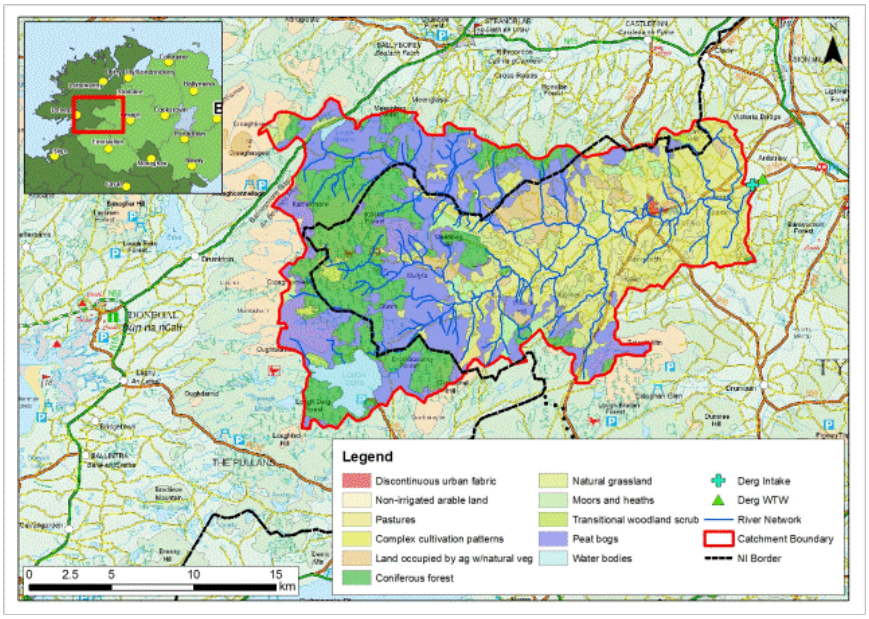


*Figure III.9 Location map case study areas in Derg catchment (Northern Ireland - Ireland).*

The SourceTo Tap project aims to deliver:

- A Catchment Management Plan;
- A Learning and Outreach Plan in the Derg Catchments through Source to Tap Project Catchment Officers (StTPOs) to effect changes in attitude to protection of water quality and the water environment;
- A cross border farm Incentive Scheme in selected sub-catchments within the Derg catchment, encouraging changes in current land management practices to reduce pesticide, colour, turbidity and diffuse pollution pressures, thereby improving overall water quality;
- UK Water Industry Research (UKWIR) cost benefits assessments of the Farm Incentive Scheme.

The farm incentive scheme will be a voluntary initiative that goes above and beyond the statutory requirements that already apply to farms in the context of the EU Water Framework Directive, Drinking Water Directive and Cross Compliance guidelines.

The Farm Incentive Scheme is currently being developed but will include mitigation measures such as:

- Technical advice/ Education;
- Application of herbicides with Weed lickers;
- Development of a farm water safety plan;
- Riparian buffer strip;
- Fencing of riparian areas;
- Herbicide Substitution;
- Biobeds;
- Stock Fencing.

In the case study area, there is already a basic platform established and on-going engagement. Prior to the StT project a low level of engagement with farmers was carried out in the catchment by NIWater in relation to pesticide usage. This included farm visits by a farm advisor, demonstration events and dissemination of leaflets

The implementation of the StT project brings together key stakeholders as either part of the StT project team or as part of the project steering committee and will cover a broad spectrum of stakeholders covering, science, policy, agri-food, and advisory from both governmental and the NGO sector. The StT project also has significant engagement with farmers through implementation of the Land Incentive Scheme and more widely with catchment stakeholders through engagement event such as citizen science training workshops, school visits and open days.

In addition, there are also existing structures as such the SCAMP initiatives and the Water Catchment Partnership which have been established for an number of years and which can be incorporated into the MAP.

The MAP is built on the StT community engagement program, land Incentive Scheme, StT project team and steering committee, the SCAMP initiative and Water Catchment Partnership, each of which have been explained and the participants detailed in the text in previous sections.

The activities of the MAP for the Fairways project will be constraint somewhat by the priority to first achieve the objectives of the StT project. Data/information collection for the Fairway project will have to take into consideration and be coordinated with data collection/activities of the StT project. This is primarily to avoid stakeholder fatigue but also to ensure the objectives of the StT are not impacted on.

See also Case studies (fairway-project.eu).

## III.10 VANSJØ (NORWAY)

Vansjø-Hobøl is a complex lake-river system in south-eastern Norway (see Figure III.10). The Lake Vansjø is used as a drinking water source, with a raw water intake in the Eastern basin.

The total catchment area is 690 km$^2$ and the Vansjø sub-catchment is 301 km$^2$. The main land management types are forest (79%) and agricultural land (17%). Surface water covers 4 % of the catchment. The drinking water source Lake Vansjø is located within four municipalities; Moss, Råde, Rygge and Våler and has a surface area of 35.6 km².

The intake is located in the part of Vansjø with the best raw water quality. The quality of the raw water varies constantly, mainly due to natural seasonal variations with varying weather and

temperatures and associated variable loads of nutrients and other pollutants. The nitrogen concentration in both Storefjorden and Vanemfjorden is characterized by strong variations from year to year, but the long-term average does not show an increase or decrease. Nitrate may also be periodically limiting to algal growth, but the nitrate amount probably predominantly controls the relationship between blue-green algae Microcystis and Anabaena in Vansjø. Blue-green algae Microcystis is dependent on nitrate and Vanemfjorden has had some summers cleared for nitrates, favoring the nitrogen-fixing algae Anabaena (which has not been shown to be poisonous in Vansjø). This situation was not observed in Vansjø in the last 3-4 years.


*Figure III.10 Location map Vansjø case study area (Norway).*

There is currently no acute main drinking water quality concern regarding Vansjø. The concern is related to the long term loads of nutrients and subsequent inlake algae development, in particular, the occurrences of toxic blue green algae together with the browning of the drinking water will be in focus. This will vary somewhat as a consequence of climate change, land use change, in particular within the agricultural sector, but partially also as a consequence of the regulation of the water level in Vansjø.

The aim of the case study is mainly to elucidate for the various stakeholder the possible consequences upon (drinking) water quality as a consequence of modelled scenarios in which i) climate change, ii) agricultural land use and (iii) the water regulation scheme are changed in the various scenarios. A secondary objective is to assess the perception of uncertainties with respect to the modelled outputs.

The main measures that will be applied in the decision support oriented modelling work is related to land use changes, predominantly agricultural change scenarios. Additionally there might also be introduced scenarios with respect to forest management measures, such as complementary nitrogen fertilization, and scenarios for the water regulation scheme regarding water levels.

The inter-municipal water cooperation regarding the Morsa Catchment/area has existed since about year 2000 http://morsa.org/ This will be the major MAP major platform used. In particular, the

thematic group on Agriculture, one out of four thematic group, will be the operational sub-platform used.

The lake Vansjø is the main waterbody of concern in the inter-municipal water cooperation regarding the Morsa Catchment/area http://morsa.org/ This is also one out of 11 inter-municipal water cooperation areas within the RBD Glomma, the largest RBD in Norway. This inter-municipal cooperation was established as Norway included about 10 % of its catchment in a “trial” period for the implementation of the EU Water Framework Directive. It started as a project in year 2000. As for most other European water bodies, lake Vansjø is governed within a multi-level governance system. The cooperation is described as:

“A board (water area committee) consisting of mayors and regional representatives, as well as professionals from municipalities and county leaders in the thematic groups, has been and is absolutely essential to gain agreement on demanding and costly measures.

In nutrient rich watercourses there are municipalities that have many of the means to act. They also have local ownership, knowledge and proximity to the residents. The municipalities therefore sit with the very key to the implementation. But the municipalities do not control all the instruments. Therefore, it is crucial that state regional authorities such as county councils, Norway's Water Resources and Energy Directorate (NVE) and the Norwegian Food Safety Authority participate actively in the work in the water area.

Good cooperation that includes dialogue with farmers and other user interests is also important. There has been close dialogue with the farmer organisations and all farmers have been offered free agri-environmental advice.”

The cooperation is knowledge driven and monitoring and assessments have been carried out since the 90’ies. Thus, broadly speaking one might state that results from the monitoring and related source apportionement analysis is the trigger. Concerning the choice of measures within the agricultural sector, the thematic working group of agricultural is the main factual decision body, but given that most measures are triggered through voluntary measures, the actual decision-maker will be the individual farmer.

See also Case studies (fairway-project.eu).

## III.11 BAIXO MONDEGO (PORTUGAL)

In Portugal we decided to group two continguous, river basins the Lower Mondego Valley and the Lower Vouga Valley. Most of the drinking water comes from groundwater extracted near the Mondego and Vouga Rivers, as they leave mountain areas and before entering the plains, which in both cases are intensively irrigated, but a significant part of the population living from agriculture, explores the groundwater aquifers for irrigation and in some cases as drinking water.

Both study sites are located at the coastal area of the Portuguese Centro Region, and belong to the same regional water authority. Although they belong to different Inter-Municipal Communities (Coimbra and Aveiro).

A recent released study states that all the aquifers monitored in Portugal presented signs of water pollution, derived mainly from agriculture and husbandry activities. The main problem is with ammoniac nitrogen and nitrates.

The main problem has to do with the excess of nutrients added to the soils, especially since increasingly, manure and wastewater sludge are being added to the soil as fertilizers, not to mention the impact of poor management of intensive husbandry that contaminates both aquifers

and superficial water bodies. For this reason, about 42% of the aquifers have nitrates concentration in excess of nitrates, at country level.

In these study regions, some surface water bodies exceed seasonally the limits of several pollutants for drinking water. In those cases, the surrounding farms see their access to subsidies cut down.

In the case study areas, soils are being used as a medium to dispose organic waste, both in a context of improving soil structure and fertility, and within a circular economy strategy that aims at the closure of energy and matter loops at local scale. In this context soils, and specially agriculture soils are the universal pollutant degradation media, playing an important role on loop closure organic materials of any organic material.

This strategy is not without risks, and for that reason the objectives of the case study are to control the addition of residues to the soil, as to keep soil quality under the legal concentrations limits, for both groundwater and surface water, around the year and particularly during the summer dry period.

Objectives in case study area:

- 50 mg $NO_3$/l in superficial water bodies and groundwater at agricultural area;
- 0,1 µg/l pesticides in superficial water bodies and groundwater at agricultural area;
- Establish a governance participatory framework, to discuss strategies and practices and implement best solutions in a swift way, toning all stakeholders in a common plan of action.

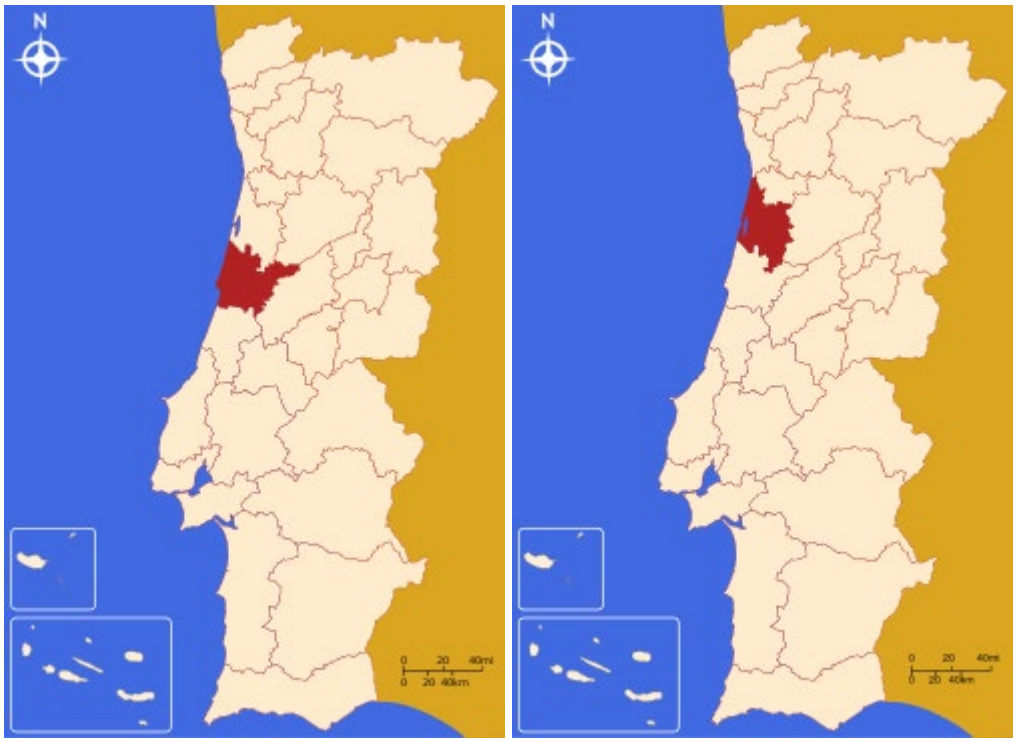


*Figure III.11 Location map Baixo Mondego case study area (Lower Mondego Vally (left figure), Lower Vouga Valley (right figure)) (Portugal).*

Targets for agricultural management:

- Assess the impact of cropping systems and establishment of application thresholds for the soils in the two study areas.
- Assess to what extent the current alternative cropping systems and crop management techniques (e.g., organic farming, integrated pest control +++), can improve or worsens the pollutant concentrations and control (for nitrogen and pesticides).

Measures identified, discussed and/or -implemented in the case study area:

- Increase manure and wastewater treatment plant's application efficiency (this has started);
- Crop rotation, with leguminous plants to improve the concentration of nitrogen in the soil and reduce the need for inputs, either organic or inorganic;
- The role of alternative cropping systems, such as organic farming and integrated protection as approaches to reduce the risk of superficial and groundwater contamination risk.

A formal advice river catchment, that involves circa 100 members, including organizational representatives and personalities, covering the entire stakeholder diversity, that ordinarily meets once a year to discuss the regional water problems and the strategies and actions to solve them could be regarded as a MAP for the river catchment.

There is, under the Regional Water Authority, an advice river catchment council (that in the Central Region of Portugal includes 3 major rivers (Mondego, Lis and Vouga), where all the organizational stakeholders take place, together with personalities and members of NGOs, farmers associations, and other organizations with interests or with an impact on water amount and quality. This is mandatory by law.

See also Case studies (fairway-project.eu).

## III.12 GIURGIU COUNTY (ROMANIA)

Water bodies protection is one of the most important aims at local, regional and national level in Romania. In order to achieve this aim, the Water Framework Directive (2000/60/EC) was transposed into national legislation by Water Law no. 107/1996 with subsequent changes and additions. Also Directive 91/676/EC relating to water protection against pollution with nitrates from agricultural sources (Nitrate Directive) was transposed into national legislation through Governmental Decision no. 964/2000 on approval of the Action Plan for water protection against pollution with nitrates from agricultural sources. According to the provisions of the Action Plan, at every four years actions must be taken: designation (re-designation) of vulnerable areas to nitrate pollution from agricultural sources; development/revision of the Code of good agricultural practices for water protection against pollution with nitrates from agricultural sources, in order to be used by farmers; development, for each vulnerable area, group of vulnerable areas with similar characteristics or at national level, as the case, of an Action Program including concrete measures for implementing the Code of Good Agricultural Practices.

Taking into account the criteria of water protection, including the principle of prevention which is applied at European Union level and, considering the presence of eutrophication at Black Sea level and the fact that all the national water resources drain in Black Sea, during the last evaluation of the stage of implementing Nitrate Directive, it was decided to apply an action program for water protection against pollution with nitrates from agricultural sources at the level of whole Romanian territory. By appying a single action program for water protection against pollution with nitrates from agricultural sources at the level of whole Romanian territory, the objectives of Nitrate Directive

are achieved. This action is an exception from the obligation of designation (re-designation) of vulnerable areas to nitrate pollution. Thus no vulnerable areas to nitrate pollution were designated.

The compliance requirements with the provisions of Nitrate Directive are also included in the Commune Agricultural Policy, as cross-compliance regulations within the subsidizing schemes and measures for farmers. Cross-compliance regulations are grouped as legal requirements in terms of environmental management and climate changes (SMR) and good agricultural and environmental conditions of land (GAEC).

Within this legal framework, farmers have to comply with different measures set out in the Code of agricultural practices for water protection against pollution with nitrates from agricultural sources, the most important ones being: storage of animal manure from agricultural farms; application of nitrogen fertilisers; interdiction periods for manure application on agricultural land.

The case study area covers three counties (Arges, Giurgiu, Teleorman) located in the Arges-Vedea watersheds, South Romania. The area lies between Carpathian mountains in the north (up to 2,500 m altitude) and Danube river in the South. Therefore, all the major geographical forms (mountain, hill, plane) are included in the area. In the studied area, there are problems related to the high nitrates contents in groundwaters.

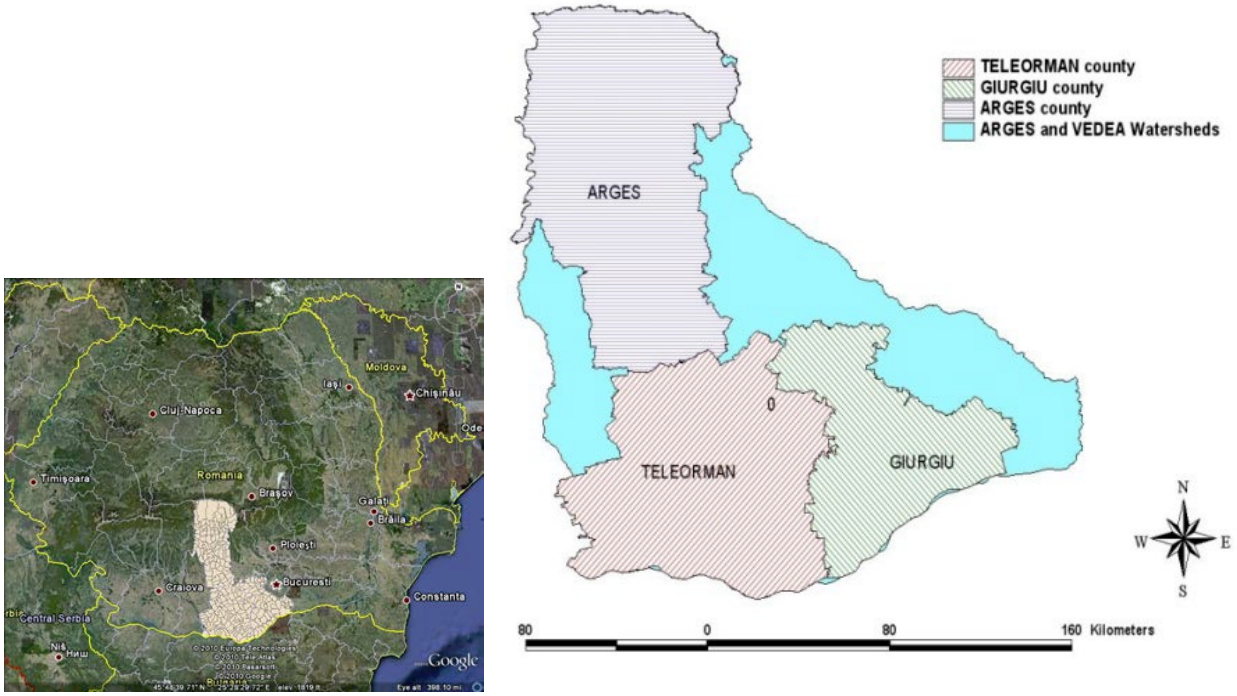


*Figure III.12 Location map Giurgiu county case study area (Romania).*

A World Bank project related to “Integrated Control of Fertilizer Use” is acting in Arges-Vedea catchment. The main objective, with regards to Fairway, is the development of measures to mitigate the nitrate flow to surface water and groundwater by:

- Development and implementation of the Code for good agriculture practices;
- Building collective and individual manure storage facilities;
- Fertilization plans at farm level according to the local pedoclimatic conditions, crop need and on-going legislation;
- Awareness rise by training farmers and local communities for preventing water pollution with nitrates from agriculture sources.

The Multi Actor Platform (MAP) is part of an on-going project on-going financed from government to implement the directive, since regional, communal and individual platforms are not well managed. In Romania the agricultural sector is divided in really small farms (50 %) and large farms (50%).

MAP-challenge:

- Wish for involvement of more stakeholders in MAPs (environmental agencies are not yet involved, the school, the church);
- Wish to involve communities (also mayors) in MAPs;
- Wish to involve large famers (don't agree to follow the rules/legislation);
- The local church is seen as an important party to increase the local involvement.

See also Case studies (fairway-project.eu).

## III.13 DRAVSKO POLJE (SLOVENIA)

Dravsko polje is an alluvial plain of the river Drava, in north-eastern Slovenia. It covers 293 $km^2$ with altitudes between 205 to 364 m.a.s.l. The area is administratively divided among twelve municipalities each one with their individual rights and responsibilities in managing land use policy and wastewaters. As water is a resource of national importance, it is on general regulated by the state as is in the case of Dravsko polje study area with two decrees on water protection zones (WPZ), one for the northern part (Decree on the water protection area for the aquifers of Ruše, Vrbanski plato, Limbuška dobrava and Dravsko polje (Official Gazette of the Republic of Slovenia, No. 24/07, 32/11, 22/13 and 79/15)) and one for the southern part (Decree on the water protection area for the aquifers of Dravsko-ptujsko polje (Official Gazette of the Republic of Slovenia, No. 59/07, 32/11, 24/13 and 79/15)). Municipalities have also the right to enforce decrees on municipal water protection zones for small water resources of local importance. For the state decrees enforcement is a responsibity of the Ministry for Environment and Spatial Planning. Implementation of the water protection area decrees is subject of an intensive process starting with (1) Verification of the existing WPA municipal authorities ordinance, (2) Verification of improvements and expert technical documents proposed by local authorities, (3) Preparation of the draft WPA decree proposed by Ministry of Environment, (4) Public consultation (municipality and stakeholders), (5) Enforcement of the decree.

Measured concentrations of nitrate ($NO_3$) in groundwater are at many monitoring points (central and lower part of the area), well in excess (40-70 mg/l) of the WFD recommended concentrations for drinking water (50 mg $NO_3$/l). The last report of the quality of groundwater in aquifer of Dravsko polje showed slow decrees over the last decade, but the chemical status of groundwater is not improving at rate expected. Measurements at wells showed that nine out of twelve (standard points) do not fulfil quality standards on nitrate for clean drinking water. While six extraction points do not fulfil quality standards for pesticides (atrazine, desetil-atrazine, metholachlor).

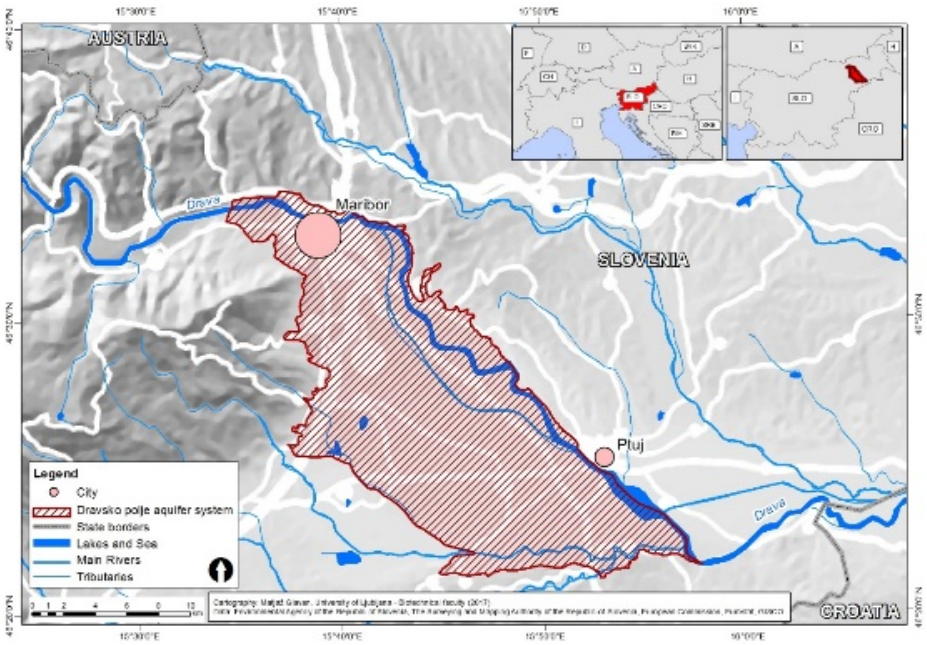


*Figure III.13 Location map Dravsko Polje case study area (Slovenia).*

Several research projects and monitoring concerning quality and quantity of ground water have been carried out in Slovenia. The Fairway project opens up a new area of research dealing with social aspects of organising an Multi Actor Platform (e.g. water partnerships) as proposed by WFD, where stakeholders associated with the waterbody can equally discuss environmental and agricultural measures focused on water quality and adopt common for all parties binding decisions.

Different initiative and measures were implemented during years like: Decree on the water protection area for the aquifers of Ruše, Vrbanski plato, Limbuška dobrava and Dravsko polje and aquifer Dravsko-ptujsko polje. Governmental act on prohibition of use herbicide atrazine (2002); Governmental act and regulations on measures for water protection zones of drinking water resources limiting fertilisers input; Limitation of nitrogen inputs in the scope of EU Nitrate directive implementation in Slovenia; Agri-environmental subsidies in the scope of Slovenian Rural Development plan for farmers voluntarily involved in the Water Resources operation (2015 – 2020); Supplemental measures for the chemical status improvement of groundwater body Dravska kotlina in the scope of new Slovenian Water Management Plan for the period 2015 – 2021; 15 years of field monitoring of nitrate and pesticides; Many years of intensive guidance and support of farmers to mitigate leaching of nitrate and pesticides; Many years of advising support of farmers by technological optimal manure application.

Decrees on the water protection area include in detailed descried measures of when, how, how much and for which crops to use certain fertilisers and plant protection products. The measures also regulate water abstraction, spatial planning (e.g. construction of buildings, pipelines, reservoirs, transport) and wastewater treatment plants and emission. The magnitude of the restrictions is defined by regime in WPZ categories (0, I, II, III – lower the number stricter the regime). Measures in the state decrees for Dravsko polje aquifer were first enforced in 2007 and from then were change in 2011, 2013 and 2015. Changes were made as part of a negotiation process between stakeholders organised in civil initiatives (farmers) or municipalities and state.

The Fairway project proposes to establish a MAP in the case study area as WFD proposes in form of Water partnership (slo: Partnerstvo za vodo), including farmers, agricultural companies (cultivators of big land parcels with low costs and extensively), agricultural and environmental

advisors (link between settlements and rural area), NGO's (consumer's organizations, other civil groups and local action groups),drinking water suppliers, Ministry of Environment and Spatial Planning (MESP), Slovenian Environmental Agency, Slovenian Water Agency, Ministry of Agriculture, Forestry and Food (MAFF), Farmland and Forest Found of RS.

MAP-challenges:

- There are many challenges and misunderstandings between different stakeholders.
- The MESP is responsible for water quality and reports to the EC on state of the water body. If water body quality is not improving the State of Slovenia could get a fine. In this manner MESP issued measures in the form of Decree on WPZ to protect itself and state interest. As current measures are not efficient enough, MESP will have to introduce new measures in the future and that will cause new complications. The MAFF is responsible for farmland management and fully support MESP and its activities.
- On the other side we do not have any clear (measured) evidence on efficiency of measures from the decree on WPZ, especially as impact are also results of CAP cross-compliance and improvements in sewage system and waste waters treatment plants. However, we (UL) modelled N balance in the Case study and confirmed that measures of the WPZ I have very strong significant impact on reduction of N leaching. While measure form WPZ II and III were negligible. As WPZ I area accounts only for 2.3% of total agricultural land of Dravsko polje case study area is impact on total N balance minor with approx. 5% reduction.
- Farmers are upset as they can't exchange land for the one outside WPZ I and as compensation payments are every year lower although production cost rise every year.
- Drinking water companies are just intermediate in transfer of the money from state to farmers.
- Farmland and Forestry Found owns a land which could be used for exchange, but land is hired by agricultural companies which they do not want to pass the land until contracts are valid.
- An established MAP will contribute to the formalisation of current occasional meetings of farmers with government. With expanding MAP with informed stakeholders and with sufficient knowledge and with support of research community the problems could be solved and misunderstandings cleared. None of the stakeholders is satisfied with current state of the problem and the solutions.

See also Case studies (fairway-project.eu).