Evaluating agri-drinking water quality indicators in three case studies

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ADWIs are defined within the DPLSIR-framework including a new 'link' type of indicator. The link indicator is developed to better explain the relationship between pressure from agriculture and state of water quality. At the time of writing this report, three of the FAIRWAY case studies, two in Denmark (Aalborg and Tunø) and one in France (La Voulzie) had sufficient data (i.e. long-term series of water quality in groundwater in combination with nitrogen (N) pressure indicators) for the required analysis of a shortlist of nitrogen, pesticide and link indicators.

Analysis reveals the relative significance of the nitrogen and pesticide indicators.

- Of the **nitrogen indicators** the agricultural **N surplus** pressure indicator is identified and reconfirmed as a suitable indicator and as a significant, prevalent, effective, and easy to use indicator regarding nitrate contamination of water. The **nitrate leaching below the soil zone** would be the most appropriate state indicator but is seldom collected because sampling equipment to measure leaching is very costly to install and to maintain for monitoring, and the results can be difficult to upscale. However, in this study, **nitrate leaching from pore water** data were available from Tunø, Denmark. This is an exceptional case and here we show how they can be used in combination with the N surplus and groundwater nitrate data. In general, the more abundant **state indicator** such as **nitrate concentrations in groundwater** is recommended as this is the standard state quality indicator.

- Selecting directly appropriate **pesticide indicators** are much more difficult than for nitrogen due to the lack of long time series of both pesticide application pressure and pesticide concentration state data. In the specific case of La Voulzie, the analyses of the two other pressure indicators (**area of main crop type** and **amount of application of pesticides**) regarding pesticide contamination of groundwater were appropriate choices of indicators. These indicators are transparent and easy to use and to communicate to stakeholders. However, they cannot be abundant indicators because it is rare that a single pesticide product is used on all the agricultural fields having the same crop type in a catchment. Therefore at specific moments, when some pesticides are intrinsically linked to the growth of crops, these two pressure indicators (area of main crop type and amount of application of pesticides) could be usable indicators of potential pesticide contamination. An attempt can be made by using **N surplus** as the pressure indicator of intensive agriculture and probable use of pesticides. It is suggested that the use of nitrogen fertilizers and pesticides is positively correlated when long time series of data are available. This link shows the joint increase of nitrate and pesticide during the rise of modern agriculture.

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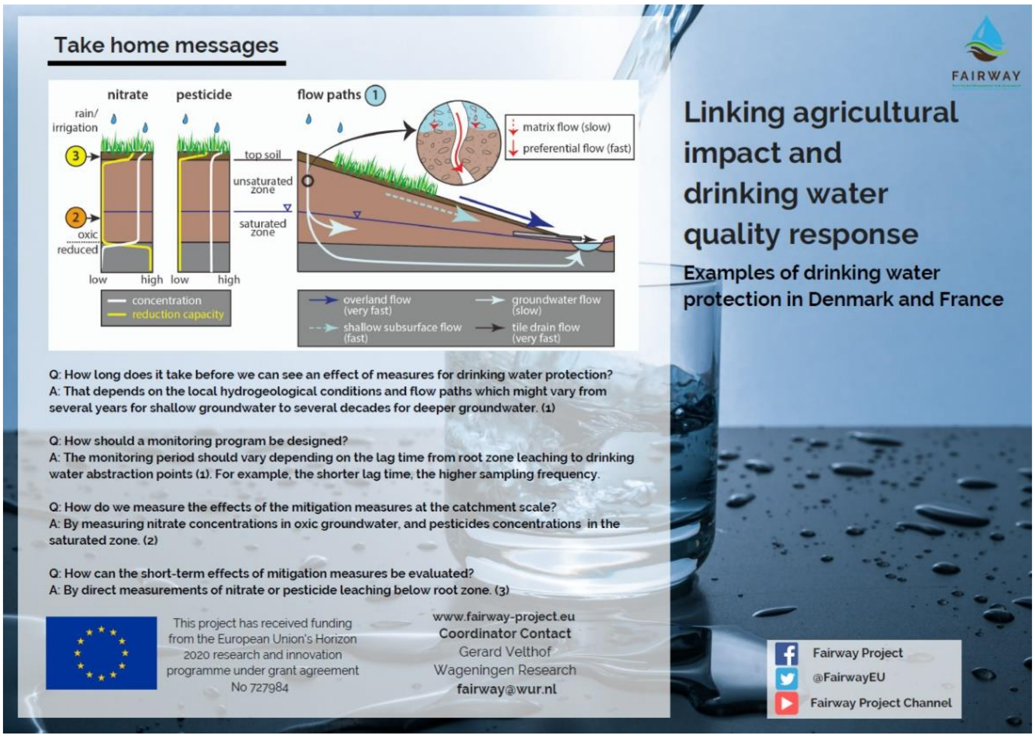
Lag times may provide a valuable insight into the mode of contaminant transport because they represent the shortest travel time that delivers the agricultural signal to the water sample collection point. In contrast, the groundwater age represents the mean residence time of the existing groundwater at the collection point. Therefore, knowledge of both groundwater age and lag time are important for protection of the aquatic environment.

A leaflet has been prepared to disseminate the importance of linking agricultural impact and drinking water quality response using examples from the 3 case studies. Workshops and presentations have highlighted the importance of coherency and consistency in agri-environmental measures since, in some hydrological context, only long-term coherent policies will produce sufficient effects. Passive samplers have been used to both involve local stakeholders in monitoring and improve water quality monitoring itself by adding an integrative sampling to point sampling.



Take home messages

Q: How long does it take before we can see an effect of measures for drinking water protection?
A: That depends on the local hydrogeological conditions and flow paths which might vary from several years for shallow groundwater to several decades for deeper groundwater. (1)

Q: How should a monitoring program be designed?
A: The monitoring period should vary depending on the lag time from root zone leaching to drinking water abstraction points (1). For example, the shorter lag time, the higher sampling frequency.

Q: How do we measure the effects of the mitigation measures at the catchment scale?
A: By measuring nitrate concentrations in oxic groundwater, and pesticides concentrations in the saturated zone. (2)

Q: How can the short-term effects of mitigation measures be evaluated?
A: By direct measurements of nitrate or pesticide leaching below root zone. (3)

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FAIRWAY

Linking agricultural impact and drinking water quality response

Examples of drinking water protection in Denmark and France

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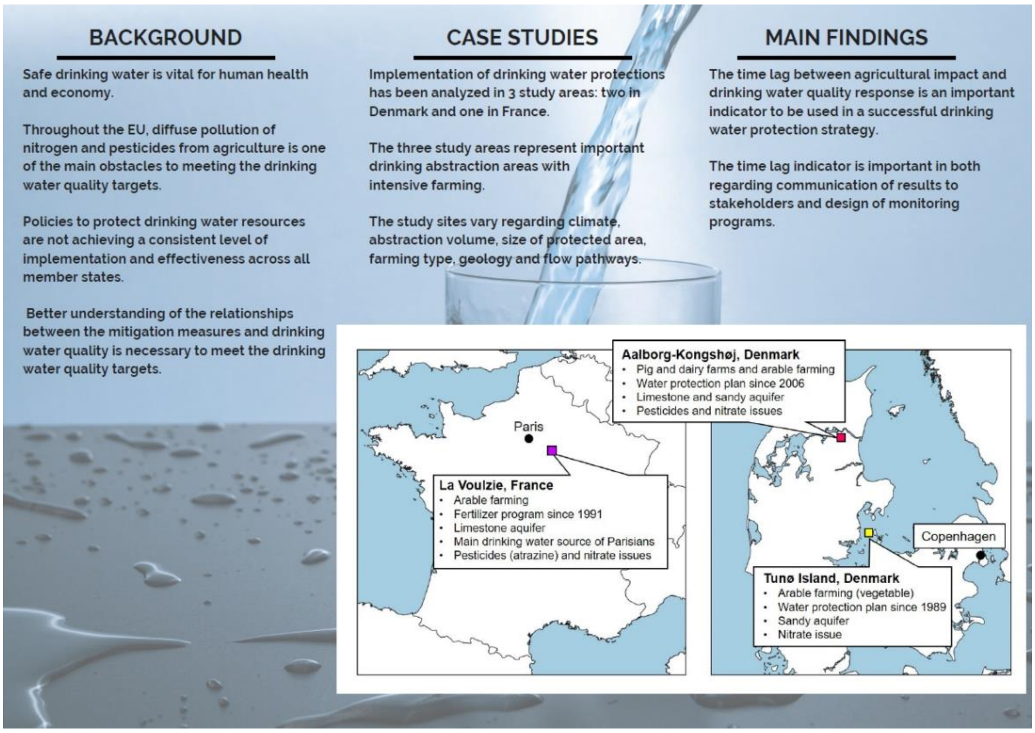

BACKGROUND

Safe drinking water is vital for human health and economy.

Throughout the EU, diffuse pollution of nitrogen and pesticides from agriculture is one of the main obstacles to meeting the drinking water quality targets.

Policies to protect drinking water resources are not achieving a consistent level of implementation and effectiveness across all member states.

Better understanding of the relationships between the mitigation measures and drinking water quality is necessary to meet the drinking water quality targets.

CASE STUDIES

Implementation of drinking water protections has been analyzed in 3 study areas: two in Denmark and one in France.

The three study areas represent important drinking abstraction areas with intensive farming.

The study sites vary regarding climate, abstraction volume, size of protected area, farming type, geology and flow pathways.

MAIN FINDINGS

The time lag between agricultural impact and drinking water quality response is an important indicator to be used in a successful drinking water protection strategy.

The time lag indicator is important in both regarding communication of results to stakeholders and design of monitoring programs.

La Voulzie, France
- Arable farming
- Fertilizer program since 1991
- Limestone aquifer
- Main drinking water source of Parisians
- Pesticides (atrazine) and nitrate issues

Aalborg-Kongshøj, Denmark
- Pig and dairy farms and arable farming
- Water protection plan since 2006
- Limestone and sandy aquifer
- Pesticides and nitrate issues

Tunø Island, Denmark
- Arable farming (vegetable)
- Water protection plan since 1989
- Sandy aquifer
- Nitrate issue