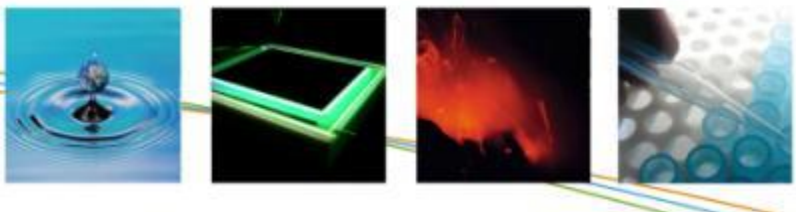
Guidelines for future, more efficient and sustainable participatory monitoring practices

Cristina Postigo, Maria Vittoria Barbieri, Antoni Ginebreda, Ester López-García, Miren López de Alda (CSIC), Enric Queralt, Vinyet Sola (CUADLL), Jordi Martín, Rosa Boleda, Agustina de la Cal (AB), Gemma Frances, Elena Isla, Anna Casanovas,
Nele Desmet, Ingeborg Joris (VITO), Elien Dupon, Ellen Pauwelyn (Inagro)
Anker Højberg (GEUS), Erling Andersen, Elisa Bjerre, Peter Engesgaard (UCPH)
Per-Erik Mellander, Owen Fenton, Shervin Shahvi (Teagasc)
Phil Jordan (UU), Brendan Cooney (WCC)
Marzena Nowakowska (PGI), Anna Kuczyńska (PGI-NRI), Zenon Wiśniowski (PGI-NRI)
Grzegorz Jarnuszewski (ZUT), Tadeusz Durkowski (ZUT), Piotr Burczyk (ITP)
Oana Rosca Mare (UTC), Alexandra Puscas (Ecologic)
Roberta Zambito Marsala, Nicoleta Suciu, Ettore Capri (UCSC)
Elisabetta Russo, Marcello De Crema, Emanuela Peroncini (ARPAE-ER)

Ref: WaterProtect D3.3
Version: v3
Date: 30/01/2020



CHANGE RECORD

Version	Date	Description
V1	08/01/2020	First draft
V2	25/01/2020	Draft with feedback from all action labs
V3	30/01/2020	Final version

Project Coordinator

Ingeborg Joris
VITO NV
Mol, Belgium
Email: ingeborg.joris@vito.be
Tel: (+32-14) 33 67 78

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement No. 727450

Content

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement No. 727450

List of Figures

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement No. 727450

List of Tables

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement No. 727450

1. Introduction

The participatory monitoring of water quality aims not only at assessing and improving the quality of water resources, but also at helping in the decision making process and increase the trust level on monitoring results and among actors. This process requires the engagement of all agents involved in water governance at different levels, and particularly those that routinely monitor water as a consequence of their responsibilities or their activities, as well as water users and research centres (see Figure 1.1).

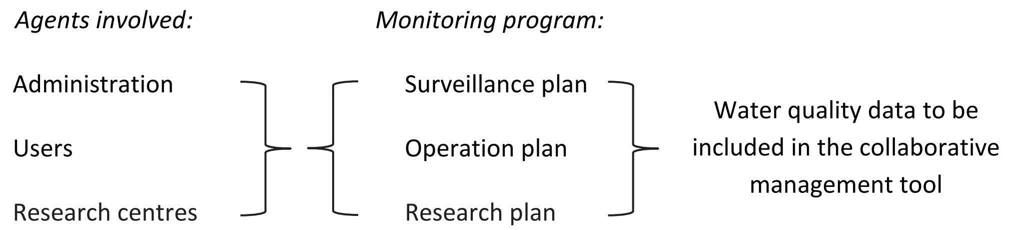


Figure 1.1 - *General scheme of a participatory monitoring approach.*

The work package (WP) 3 "Participatory monitoring" of the WaterProtect project aimed at establishing new, participatory monitoring approaches in the project action labs, which represent very different conditions in terms of:

- location and environmental zone (Atlantic North, Atlantic Central, Continental, Alpine South, Mediterranean North, Mediterranean South),
- land use (rural or mixed urban/rural),
- farming system (grass, field crops, vineyards),
- irrigation,
- catchment size (from 10 to 206 Km^2),
- source of drinking water (surface, ground water or both),
- kind of pollution problems (nitrates, pesticides or both), and
- extent of knowledge in this last respect.

In this context, on the basis of a previously commonly agreed general approach, different participatory monitoring programs were established in each action lab according to their particular realities. These approaches are summarized in Table 1.1 and described in detail in the two previous deliverables prepared within the WP and already submitted to the European Commission (***D3.1. Harmonised pollutant monitoring databases in the case study areas including analysis of data***, and **D3.2.** ***Additional targeted pollutant monitoring databases, including analysis of data***).

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement No. 727450

The design of specific monitoring programs in each case was performed after the compilation, harmonization, and evaluation of existing historical data, the identification of information sources and gaps, selection of the most relevant parameters in terms of water quality to be monitored, as well as of the most relevant and meaningful sampling locations in each area. In those cases where no data on water quality was available at the start of the project an initial surveillance plan was established, while sites with already well stablished surveillance plans set up advanced targeted participatory monitoring plans with different objectives established on the basis of the information gathered during the first year of the project and the main gaps identified. Thus, in some cases the monitoring plan performed aimed at producing the first data ever available for the area of study, as it is the case for certain pesticides in the vineyards of Italy, whereas in others the objective was (i) to screen the area for plant protection products (PPPs) or nutrients in order to identify the most critical compounds and sites upon which focusing potential mitigation measures to improve the overall water quality of the zone, (ii) to evaluate the effect and contribution of rain events, erosion and/or runoff processes on pesticides loads, as in Belgium or Ireland, (iii) to identify the source (either inorganic or organic) of nutrients pollution through isotopic analysis, as done in Poland or Spain and Italy, (iv) to evaluate the efficiency of new best management practices (BMPs) implemented within the project, as done in various of the sites, or (v) to simply get involved additional actors, such as school children, in the monitoring, as performed in Romania through the use of simple kits for analysis of nitrogen species in groundwater.

Since each catchment or case-study has a different nature and reality regarding information available, a customized participatory monitoring approach needs to be adopted in each case in order to answer the questions and cover the information needs relevant for each particular action lab. Notwithstanding this, there are a series of common issues important to be considered in any case. The present deliverable **D3.3 "Guidelines for future, more efficient and sustainable participatory monitoring practices"** provides guidelines to design successful participatory monitoring practices in any area. These guidelines have been drawn from the lessons learned from the participatory monitoring approaches implemented in each action lab within the project WaterProtect. Despite the fact that this project was conducted to search solutions to protect drinking water resources from pesticides and nitrates pollution derived from agricultural activities, the guidelines here provided could be applied to set participatory monitoring practices under any other pollution threat scenario.

With this last deliverable (and the two previous ones), the initially formulated specific objectives of WP3:
1) Design the participatory monitoring approach together with the actors;
2) Collection of existing water quality monitoring data (including surface, ground and drinking water) in the case studies;
3) Harmonization of data for further use in the collaborative management tool developed under WP 5 within each case study; and

4) Design and implementation of additional, targeted participatory monitoring campaigns to evaluate the effectiveness of measures and farming practices, and
5) Summarising the lessons learned from targeted participatory monitoring campaigns for disseminating to other areas,
should have been successfully fulfilled.

In the overall context of the project, the data and information generated within this WP has also contributed to the good progress and realization of WP2-Water Governance (helping in the decision making), WP4-Best management practices (assessing in the evaluation of already in place or new BMPs), WP5-Collaborative management tool (feeding data), and WP6-Upscaling to EU (providing useful data and tools applicable to other areas).

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement No. 727450

Table 1.1 **–** Summary of the participatory monitoring plan established in each action lab based on their characteristics

Action lab (country)	**Land use (size)**	**Environmental zone***	**Pollution problems**	**Water quality historic data**	**Participatory monitoring plan designed and implemented to cover information gaps or produce additional valuable information**
Bollaertbeek (Belgium)	Mixed urban/rural (23 Km^2)	ATC	Pesticides	Yes	47 pesticides; two additional monitoring sites with high-resolution monitoring to assess the contribution of different pollution pathways (point sources, and runoff/erosion).
Vester HJerk (Denmark)	Rural (27 Km^2)	ATN	Nitrates	Yes	Additional geophysical, hydrological and chemical information to improve delineation of the groundwater capture area. Monitoring of farming practices to identify relevant sources and water quality monitoring from 22 drain pipes. Nitrates and physical-chemical parameters in waterworks and streams are routinely monitored.
Wexford County (Ireland)	Rural (12+11 Km^2)	ATC	Nitrates and pesticides	Yes	17 herbicides and nitrate in 82 groundwater wells. 10-min analysis of nitrate in surface water at catchment outlets. Dynamics of herbicides, specially MCPA, using biweekly time-integrated samples of surface waters.
Val Tidone (Italy)	Mixed/Urban-rural (206 Km^2)	MDN	Nitrates and pesticides	Yes	Targeted monitoring of 15 pesticides, Cu, and nitrates in 26 private and public wells and analysis of stable isotopes of nitrogen species. Additional geophysical, hydrological and chemical analyses to identify relevant contamination sources.
Gowienica River (Poland)	Rural (60 Km^2)	CON	Nitrates	Yes	Nitrates, sulphates, phosphates, ammonium ion, chlorides, elements: B, K, Mg, P in 17 sampling points: 9 groundwater (quarterly), 8 river water (monthly), 3 wastewater treatment plant discharges (quarterly); 2 hydrological years of sampling campaigns, Analyses of N and O isotopic composition in 2 groundwater vertical profiles, public supply well and river water, infrared camera imaging.
Mara River (Romania)	Rural (20 Km^2)	ALS	Nitrates	Partial	19 sampling locations: 14 groundwater (once in 2018) and 5 surface water (3 seasonal in period 2017-2018). Analysis of physical chemical and nutrients and macrozoobenthos communities, and evaluation of riparian vegetation.
Lower Llobregat River (Spain)	Mixed urban/rural (120 Km^2)	MDS	Nitrates and pesticides	Yes	Targeted monitoring of 108 pesticides and analysis of stable isotopes of nitrogen (N), oxygen (O) and boron (B) species: 11 surface water and 6 groundwater sampling sites; 2 sampling campaigns: winter, summer (also physical-chemical characterization). Targeted monitoring of 50 pesticides in 7 river sediments and risk assessment

ATC Atlantic Central; CON Continental; ATN Atlantic North; MDN Mediterranean North; MDS Mediterranean South; ALS Alpine South

2. Design of an effective participatory monitoring approach.

As previously indicated the design of an effective participatory monitoring approach to improve the quality of water resources requires that all actors conducting water monitoring and using water in the area get involved and engaged, so that information at different levels that addresses their different specific needs is collected. Furthermore, all data on water quality historically available in the area or newly produced need to be compiled and harmonized so that they can be properly evaluated. The data available need to be jointly examined by the various actors to identify information gaps. Based on this joint evaluation, specific monitoring plans are designed. The process is summarized in Figure 2.1 and each step involved in the process is thoroughly described in the next sections. As Figure 2.1. shows, a big effort has to be done at the beginning of the process. However, once that actors are engaged and data harmonized, the process becomes smooth and effective in designing specific monitoring programs according to the needs of each specific catchment or area. Note that it is not a static process.

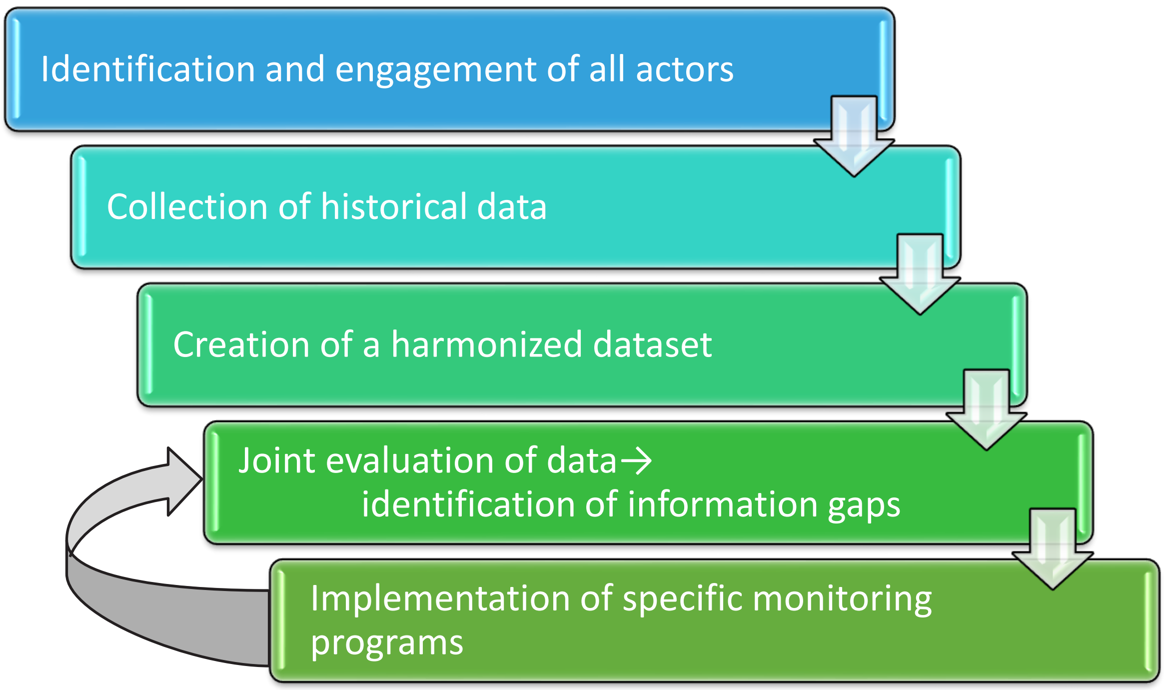


Figure 2.1 – *Steps involved in the implementation of a participatory monitoring approach.*

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement No. 727450

2.1. Identification and engagement of all actors/sources of information

Relevant water actors or stakeholders are those that affect or are affected by the water quality. The main reason to get them engaged in a participatory monitoring process is that they will influence future monitoring programs and these will affect their lives, as they will contribute to protect water resources.

There are two large groups of water actors (see Figure 2.2) that need to get involved in the participatory monitoring process:

- Local water users (i.e., farmers, industry, and overall, end users), as they can
  - provide detailed information on water uses and needs in the area, and potential pollution sources, and
  - provide access to sampling sites and private wells, and thus, increase the spatial resolution of the monitoring area.
- Actors that conduct water monitoring in the area on a routine basis and produce water quality data either at local or regional level (water management authorities, drinking water producers, wastewater treatment plants, and special activities: construction works, airports, etc.), as they can contribute with their data and knowledge.

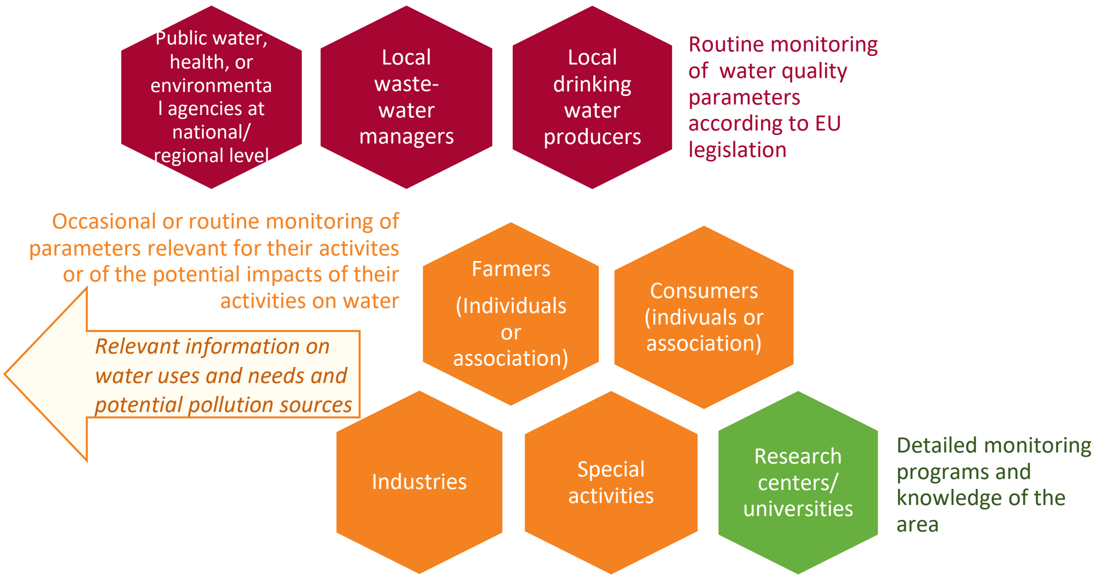


Figure 2.2 - Water actors to be involved in the participatory monitoring approach and information that they can provide.

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement No. 727450

In order to involve the right actors in the process it is necessary to map all stakeholders in the area and their roles, responsibilities, influence, motivations, and levels of connectivity[1]. Communication and transparency of all steps given during the process and of the results obtained during implementation of the monitoring programs contributes to increase trust among actors and engagement in the process. Furthermore, connectivity among stakeholders may be enhanced by the process.

In the framework of the WaterProtect project, successful engagement of water actors was achieved through the organization of multi-actor workshops and also through individual focused meetings. For specific groups of water actors (e.g., farmers), engagement was achieved by focusing activities in events/places frequently visited by water actors (e.g., trade fairs, bars/restaurants in the area where farmers meet after work).

The main limitations to achieve a successful stakeholder engagement could arise from the lack of leadership and funding to drive the engagement process. Besides needing human resources to organize and lead engagement activities, logistic expenses related to the organization of meetings or the production of sensibilization and/or support material are required for a successful engagement.

2.2. Collection of historical data

During this stage, the participating water actors should provide information and data on the different monitoring programs they conduct in the area on a routine basis or occasionally due to specific events. It should be also identified whether these water quality data are produced in the framework of surveillance, operational or research monitoring plans. ***Surveillance plans*** include regulatory monitoring programs, ***operational plans*** include those monitoring programs conducted to perform a specific activity or prevent its impact, and ***research plans*** include those monitoring programs conducted to investigate in detail specific events/aspects.

The following information on water quality monitoring should be extracted from each water actor at this stage:

- the parameters monitored (chemical and biological),
- the frequency of the monitoring programs (annual, seasonal, monthly, daily, etc.),
- the year in which the monitoring of a specific parameter started
- the compartments monitored (groundwater, surface water, sediments, soil),
- the locations monitored in the catchment area, and

[1] Akhmouch A and Clavreul D. 2016 Stakeholder engagement for inclusive water governance: "Practicing what we preach" with the OECD Water Governance Initiative. Water, 8:204.

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement No. 727450

- the number of data available for one parameter in one specific location and compartment (see Table 2.1 for an example).

Table 2.1 *– Example of the summary table of the monitoring programs conducted in the catchment by a specific water actor.*

Actor	Water Agency		
Monitoring plan	Surveillance		
Monitoring locations	***Number***	***Frequency of sampling***	
Groundwater	36	Annual	
Surface water	2	Monthly	
Parameters monitored in groundwater	***Type***	***Start year***	***Amount of data***
	Nitrate	2003	300
	Atrazine	1996	528
Parameters monitored in surface water	***Type***	***Start year***	***Amount of data***
	Nitrate	2005	78
	Atrazine	1996	528

Besides having an initial overview of the water quality data available in the area it is also important to collect detailed data on the geological, geophysical, and hydro(geo)logical characteristics and land cover. This can be achieved after engagement of experts in these fields and personnel from research institutes or universities. The final aim of this type of explorations is to delineate groundwater capture zones of waterworks in order to protect them, to evaluate water resources in the area (in terms of quantity), to identify areas vulnerable to groundwater pollution to protect them, or to identify land uses or human activities that may potentially release pollutants into water to control them.

Furthermore, regarding water uses, it is necessary to investigate in detail the different economical activities in the area in terms of water demand and practices that may impact water resources. For instance, in the case of agricultural activities, detailed information on farming practices (e.g., amount, frequency, and type of plant protection products and fertilizers applied, irrigation methods and infrastructure, type of crops, agricultural areas drainage, etc.) would contribute to implement appropriate best management practices and reduce risks of pollution of water resources. This information can be obtained through the organization of workshops or what was found to be more effective, with face to face interviews in the farms.

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement No. 727450

2.3. Creation of a harmonized dataset

All water quality information available in the catchment and the data produced in the monitoring programs conducted within the participatory monitoring process need to be harmonized. That is, specific metadata need to be provided and electronically archived following an agreed structure/template. This facilitates sharing water quality data among all water actors, which at the same time increases the trust level on the data and among actors, and also gives the possibility to easily upload all data in a digital platform that facilitates their analysis and visualization.

The database should be built using static and dynamic fields, and specific requirements should be also taken into consideration as indicated below.

2.3.1. Static fields

A harmonized database should have unique codes for monitored locations and parameters. These fields are **static**, as well as the metadata associated.

- ***Monitoring site ID***

  Metadata:
  - *GIS location* (X-coordinate and Y coordinate, UTM)
  - *Z-coordinate* (depth below ground), diameter, well use, status, in the case of groundwater monitoring sites
  - *Type of sample* (river, lake, groundwater, drinking water, effluent wastewater, reclaimed water, drainage channels, rain water, recharge water, etc.)
  - *Water body*
  - *Owner,* in the case of groundwater wells
  - *Administrative data* (contact person, address, phone number, email, consent to store data) (see specific requirements below)
  - Municipality
  - *Additional location description* as secondary tables (reference points, pictures, ownership, inspection reports, soil type, vegetation, any other information relevant for the monitoring site) (optional)

- ***Quality parameter ID***

  Metadata:
  - Full name
  - Contaminant group
  - Type (chemical, physical or biological)
  - Units

- ***Quantity parameter ID***

  Metadata:
  - Piezometric levels (aquifers) or flow (rivers)
  - Meteorological data (rainfall, temperature)
  - Units

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement No. 727450

2.3.2. Dynamic fields

These fields are related to the data generated for each parameter and in each monitoring site. They include:

Date of monitoring/sampling (dd/mm/yy)
Measurement value itself
Laboratory data (name of laboratory, method limit of quantification)

Additionally, with respect to the environmental quality standards (EQS) defined in the Water Framework Directive for surface waters (Directive 2013/39/EC) and groundwaters (Directive 2006/118/EC), status of each sampling location and hence water body should be indicated:

- Quantitative (good/bad)
- Qualitative (good/bad):
  - chemical (groundwater and surface water)
  - ecological (surface water)
- General (good/bad)

2.3.3. Specific requirements

Confidentiality of data collected should be defined ahead, and different security levels must be established, when uploading the database into a collaborative tool or just sharing it.

For instance, the Water Framework Directive 2000/60/EC, in agreement with ***Directive 2003/4/EC on public access to environmental information and repealing Council Directive 90/313/EEC***, requires sharing information on river basin management plans and water quality, and promotes public participation. However, ***a recent European Regulation 2016/679*** on the protection of natural persons with regard to the processing of personal data and on the free movement of such data that repeals Directive 95/46/EC would not allow to share certain information (for instance, the ownership of the sampling point (well)).

Moreover, letters of confidentiality by water actors that generate the data may restrict some data sharing for a period of time, and other situations should be considered, such as the protection of research outcomes for scientific publication.

There should be a consensus on **data format** among all laboratories/entities producing data. This applies to the use of a universal code for each parameter, date format, measurement units, and what it is of high relevance and sometimes overlooked is how to report values below method limits of quantification.

This project has received funding from the European Union's Horizon 2020
Research and Innovation Programme under grant agreement No. 727450

2.4. Joint evaluation of data – identification of information gaps

As previously indicated, the different nature of each catchment, as well as the historical information available in each case, requires the adoption of participatory monitoring approaches specifically designed for each site. A joint evaluation of the historic data and the knowledge available in the area is required to identify information gaps that need to be covered to protect drinking water resources, and to set the questions that future monitoring programs will answer.

Besides integrating the knowledge of each water actor and objective information contained in the harmonized database, using geographical information system-based tools (i.e., mapping of monitoring locations and land cover) can help identify those areas with no or few data available, and also specific activities that may be impacting or threatening drinking water resources. The use of hydrogeological models was found to be very helpful in the assessment of pollution-vulnerable zones of aquifers used for drinking water abstraction, and delineating groundwater abstraction zones that should be subject to special protection.

2.5. Implementation of specific monitoring programs

Participatory monitoring programs must be designed according to the information that is already available in the specific catchment of study (see Figure 2.3). Although very specific questions will raise in each catchment in relation to its specific circumstances, among the general questions that need to be answered in all cases for effective management and protection of drinking water resources, are:

- How is the quality of the surface and groundwater in the proximities of the points of abstraction of water for drinking water production?
- What are the main pollutants threatening the drinking water resources?
- Are pollutant levels above EQS in surface and groundwater?
- Where are the most contaminated sites in the area?
- What are the main pollution sources in the area?
- What mitigation measures or best management practices could be put in place to reduce pollution?
- Is the drinking water supply threatened by the amount of water resources available in the area?

Thus, if no information to answer the questions above is available in the area, participatory monitoring programs should strictly focus to answer these questions. To evaluate water quality for the first time in an area, monitoring stations should be established in the water courses or in wells downstream potential pollution sources (e.g., wastewater treatment plants, agricultural fields,

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement No. 727450

urban areas, industrial areas), and in reference sites that are expected to be free of pollutants or polluted to a lesser extent. Then, chemical parameters, including suspect or specific pollutants of concern, and/or biological parameters should be analysed in the selected water monitoring stations. The use of passive sampling or collection of composite samples is important to cover pollution peaks in surface water and not underestimate pollution of drinking water resources. Thus, pollution monitoring of water resources using this type of time-integrated samples is recommended. Then, results obtained in the different monitoring stations should be compared among them, in time, and with European water quality standards (EQS set for surface and groundwater under the Water Framework Directive). The concentrations found, the frequency of detection and the exceedances of European water quality standards can be used to prioritize those compounds that threat water quality and identify pollution sources to control and/or reduce them.

The engagement of water users in pollution monitoring (school children, well owners) raises awareness on the need to protect drinking water resources and trust in the water quality data.

In areas where groundwater is the main source of drinking water, it is highly relevant to delineate the groundwater abstraction zone as well as to characterize groundwater flow and aquifer hydrogeology. When this information is lacking, monitoring programs should also be directed to study these aspects so that groundwater can be effectively exploited and protected.

In those areas where relevant water quality data are already available, more specialized monitoring programs should be implemented to investigate pollution sources in detail, so that appropriate pollution mitigation measurements can be implemented. This requires more specialized analytical techniques and/or monitoring strategies (e.g. high spatial resolution and/or time-integrated collection of surface water samples). For instance, once that distribution of pollutants in the water catchment is known, the fate of pollutants in other environmental compartments (i.e., soils and sediments) can also be evaluated, as they may be potential sources of pollutants into drinking water resources. Furthermore, advanced analytical techniques that investigate the distribution of stable isotopes of N, O and B can be used to investigate in detail pollution sources (e.g., organic or inorganic origin of nitrates, and agricultural manure *versus* sewage leakage organic sources) so that they can be reduced. Another example is the screening of larger pollutant lists including compounds of currently high concern, such as those included in the Watch List (COMMISSION IMPLEMENTING DECISION (EU) 2018/840), which in the case of pesticides include neonicotinoids, methiocarb and metaflumizone.

Increasing and sharing the knowledge on water quality does not contribute to protect drinking water resources if no measures are taken to reduce the pollution sources identified in each case. This can be achieved by promoting best management practices (e.g., in the case of agriculture, reduce pesticide and fertilizer use, use technology available to optimize their application, or use of designated sites to safely wash sprayers after product application and to recover the wastewater), and improving the treatment of polluted waters discharged into the aquatic environment by upgrading wastewater treatment plants or constructing small and sustainable bioreactors for *in situ*

This project has received funding from the European Union’s Horizon 2020 Research and Innovation Programme under grant agreement No. 727450

remediation of contaminated waters (agricultural fields drainage waters or industrial effluents). In catchment areas where water resources cannot meet the drinking water supply requirements due to an increasing demand or frequent draught periods, the use of additional water resources (i.e., regenerated wastewater) for specific uses (e.g., agriculture, industry) should also be considered and investigated as a potential measure to protect drinking water resources. Participatory monitoring programs should also evaluate the effectiveness or the impact of the mitigation measurements implemented in a specific area.

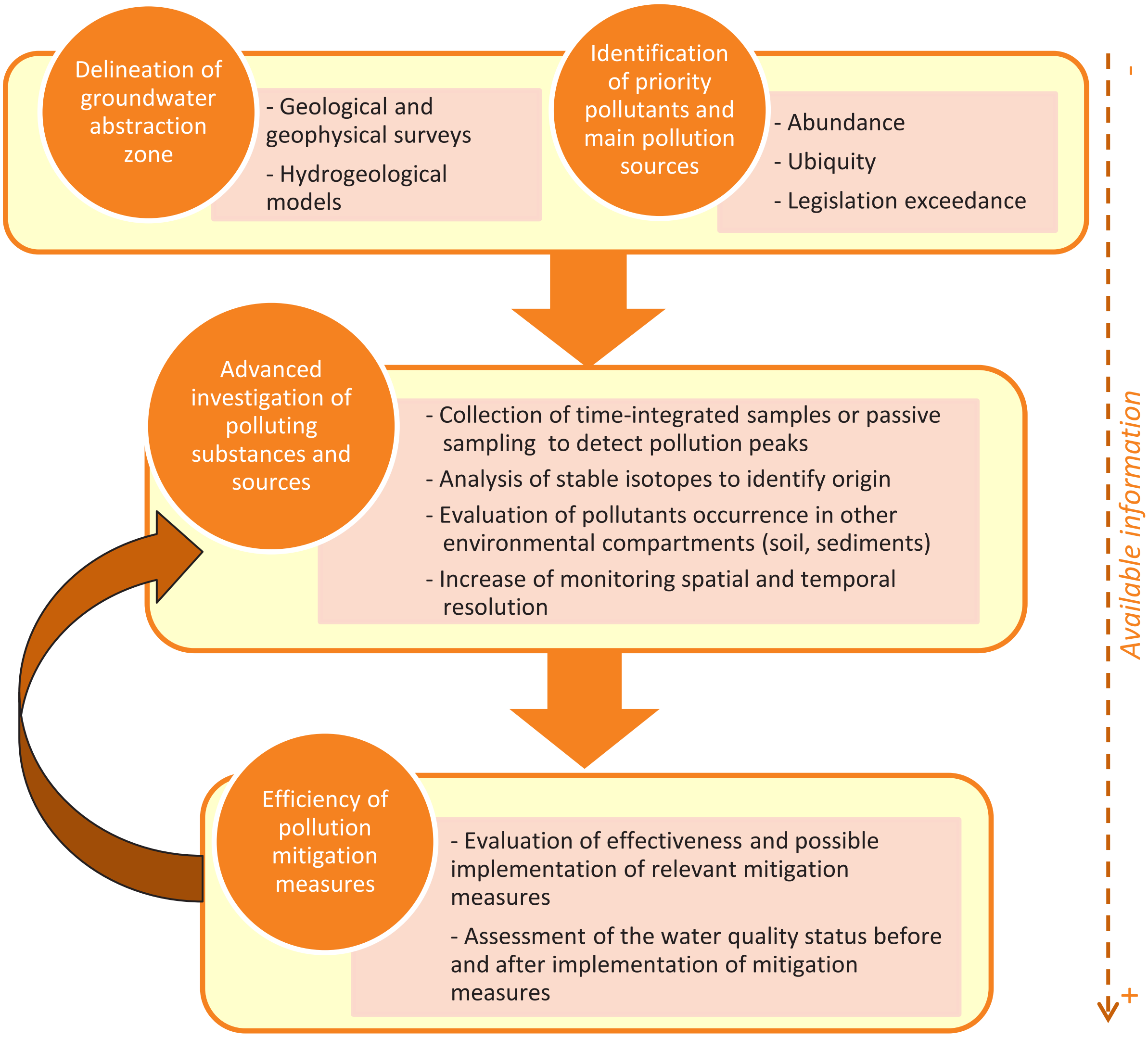


Figure 2.3 *– Design of participatory monitoring programs depending on the information available and needed in the area.*

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement No. 727450

3. Conclusions

The guidelines here provided were elaborated from the lessons learned after implementing participatory monitoring approaches in the action labs of the WaterProtect project. The first lesson learned is that each catchment has its own nature and circumstances and therefore a specific participatory monitoring process will only fit the catchment for which it was designed. Notwithstanding this, a general structure of the process has been elaborated together with recommendations to follow in each included step. The engagement of all water actors in this process is crucial but its successful realization is subject to economical funding to some extent and also the designation of a leader to drive the process. Furthermore, water quality data in the area need to be harmonized for successful integration and evaluation. Overall, the monitoring programs resulting from the participatory monitoring process have three main objectives: i) identifying priority pollutants in water and pollution sources, ii) delineating (groundwater) abstraction zones, and iii) evaluating the efficiency of mitigation measurements. However, the objective of a specific monitoring program has to be established according to the historical data on water quality already available in the area. This is not a static process and the results of each monitoring program have to be evaluated by all water actors engaged in the process to set the objectives of future monitoring programs and measures. Joint examination of data is essential to understand each other’s needs and positions and elaborate management plans that benefit all actors. These general guidelines can be used to design a participatory monitoring approach in any catchment to protect drinking water resources from pollution derived from agriculture or other human activities.

This project has received funding from the European Union’s Horizon 2020 Research and Innovation Programme under grant agreement No. 727450