Simple to use set of indicators that are easy to communicate and use in participatory governance water processes with the involvement of farmers and citizens

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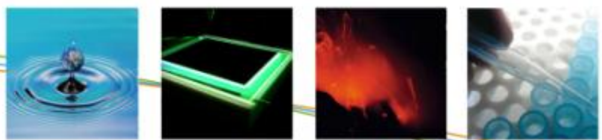

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Introduction

The wider research community recognise that management of water in a sustainable way "*is a key for the future of food and agriculture*" (OECD.org). Improvement of water resource use efficiency and reduction of water pollution from agricultural systems is seen as one of the main policy challenges. Farming accounts for 30% to up 60% of water used in Europe and contributes to water pollution sourced from nutrient, pesticide and other pollutant discharges (OECD.org).

Sustainable water management in agriculture aims to match water availability and water needs in quantity and quality, in space and time, at reasonable cost and with acceptable environmental impact. This involves an understanding of technological problems, social behaviour of rural communities, economic constrains, legal and institutional framework and agricultural practices (Chartzoulakiset al, 2015).

The concept of water sustainability has become increasingly prominent in agricultural policy debates and the questions of evaluation of agricultural water resource uses and agricultural practices, raised the question of the design and selection of indicators to assess sustainability aspects of practices (Latruffe, 2016).

Many recent approaches to achieve the challenge of increasing agricultural production, while reducing its environmental impact, are based on evaluation of the increasing of the efficiency of agricultural production and the use of innovations as a measure of the long-term sustainability. Several research programs, aimed to foster the adoption of sustainable practices, with involvement of farmers, were developed, also in a multi-stakeholder process; many studies have been proposed and several assessment methods developed. However, such a huge amount of products on sustainability, underlines limitations related to the fact that the subject matter is very complex and is addressed differently according to the sciences which are approaching it. The main constraint relates to the fact that sustainable principles, as pointed in Sala et al (2015), may have different basis and perspectives depending on the geographical region in which they are developed "*because of the deep cultural peculiarities and differences associated with these areas*", and is now well recognised by the scientific community that "the variability and role of value judgements in sustainability assessment tools is inherent to the interpretation of the concept of sustainability" (Bell and Morse, 2001 and 2008). Although the sustainable development concept is "simple", to demonstrate that research, policies and regulations cause measurable changes in environmental and social quality, is complex. Indeed, even when the changes in the quality of an environmental compartment can be monitored reliably, links between actions (of a government, but also behaviour of individuals involved in the process), impacts on the environment, and health and wellbeing, are rarely direct or linear. Different sustainability frameworks could be defined in function of the targets, the decision context, the methodological choices for the assessment. Several sustainability indicators covering economic, social and environmental aspects of human activities have been produced (Hueting, 2004).

In addition, the most recent literature reviews on the topic (see Chatzinikolaou et al, 2012, Gaviglio et al, 2016, and Latruffe et al, 2016) report that due to the high variability across farms, even within given individual contexts and farming systems, the different dimensions of sustainability (the environment, economics and social ones) are not equally prioritised and integrated.

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There is a lack of consensus amongst experts about how best to measure agricultural sustainability and indicators to assess agriculture sustainability are mainly related to environment, with little regard for the economic and social domain.
In this framework also the OECD scoping note (OECD, 2016) highlights that building up water governance indicators is a challenging task and indicates a series of issues that need to be taken into account (Figure 1 from OECD) - as reported and summarised below (for more details please refer to the original document):

- A number of **technical** issues: eg measurement errors, coherence of measurements, biases in expert assessments.
- **Complexity**: multiple dimensions not easy to measure, high degree of fragmentation and messiness of the water sector compared to other natural resources of infrastructure sectors.
- **Uncertainty**: policy makers have limited control on factors that might affect the effectiveness of water governance.
- **Continuity** scarce data availability could hinders the measurement of progress year after year.
- **Completeness:** indicators fail to capture the whole picture.
- **Comparability:** indicators are not necessarily standardized measures applicable to all contexts unconditionally and given the diversity of situations including in terms of data quality across and within countries.
- **Causality** between instruments and results are difficult to be established and should not be underestimated since established indicator system might not be able to assess whether or not benefits are the results of certain actions implemented to achieve effective water governance.

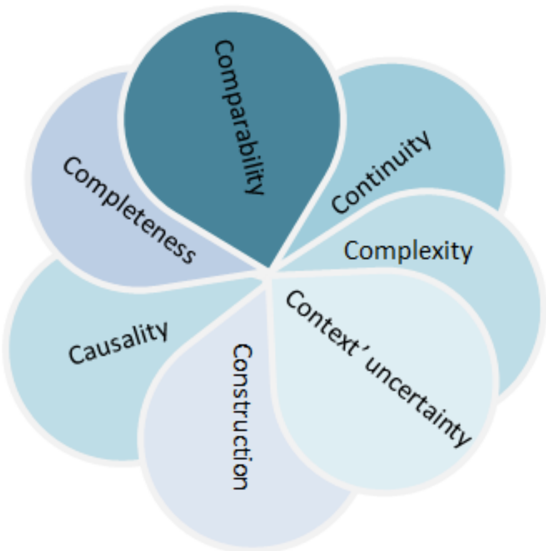

Fig 1 Issues to be taken into account when building up water governance indicators (from OECD scoping note, 2016)

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Despite all the uncertainties and limits described above, a growing number of sustainability assessment tools have been created to support farmers and policymakers to develop agriculture in a sustainable way that include also the subject “water” in the evaluation.
However, sustainability assessment tools and the indicators included vary widely due to differences in value judgements, prioritizations in the selection of indicators, spatial and temporal scales, system boundaries, and target groups.
The lesson we learn after an analysis of the state of the art is that there is “general consensus” mainly on two points:

- a clear and transparent problem formulation at the outset of the evaluation is fundamental to find a common understanding of the priorities and protection goals;
- measuring what needs to be improved is essential to provide a tangible, consensual and objective base that can trigger collective action.

This is in line with the WaterProtect ambitions as written in DoW and with the objective of task 7.3. The task focus is to produce a simple to use set of indicators which build further on the EWP indicators that are easy to communicate and use in participatory governance water processes with the involvement of farmers and citizens. Task 7.3 of WaterProtect will also look at how such indicators can be used to contribute to a broader sustainable water management in agriculture and issue guidelines or recommendations to that effect for stakeholders.

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1- Project Goals And Objectives

Objective of task 7.3 of WATERPROTECT project is to create a toolbox of indicators for water management in agriculture.

The problem that needs solving is to capture the contribution that farming system can have on water management taking into account that the seven case studies of the project cover different climatic conditions, different types of farming systems, different legal frameworks, larger and smaller water collection areas.

General aim of the task is sustainable water management in agriculture whose assessment could contribute to target the water governance in a better way.

Linking water management and water governance is complex mainly due to:

- the uncertainty determined by the multiple dimensions of the water sector "per se"; difficulties in comparing data, given the diversity of situations including in terms of data quality across and within countries "as indicators are not necessarily standardized measures applicable to all contexts unconditionally".
- policy makers have limited control on factors that might affect the effectiveness of water governance as pointed also in the OECD reports

However, even if the goal of the task is not to formulate governance indicators, the work carried out in the various WPs of the project, gives us the opportunity to link the two aspects, (water management in agriculture and water governance) and to provide targeted indications for a more effective water management and policies on the territory.

Two requirements are expressly indicated in the DoW:

A-the toolbox should include indicators related to the following topics:

1-water quality and quantity issues including pressures arising from agriculture
2-uptake of best management practices in agriculture;
3-sustainability of water management approaches;
4-role of land management decisions in water quality,

B-Indicators will build, upon existing and further develop indicators, in detail the European Water Stewardship (EWS) standards.

This standard was originally designed mainly for certifications purpose; to verify the compliance against a data set, in order to verify the progress and the willingness to improve the situation of the certification subject compared to a baseline. WaterProtect will adapt this framework to the WaterProtect goals and objectives, since certification is out of scope of the project.

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2 - State Of The Art

This evaluation was aimed at selecting existing frameworks and related indicators that could feed the Waterprotect indicator toolbox.

Recently, various bodies, organizations and European projects have already approached the topic and therefore the present work benefits from an already exhaustive analysis of the literature.

Therefore the scope of this section is not to list and comment on the different approaches but to explore the state of the art of sustainable agriculture water management/governance indicators, providing a common frame of reference.

What is described in the next paragraphs is a focus of what we considered relevant with respect to the objectives and goals of the task: water management in agriculture and sustainability in farm systems.

International Frameworks

2.1 Driver-Pressure-State-Impact-Response Framework (DPSIR)

The DPSIR is a conceptual framework widely used for assessing water issues. It identifies the relationships between *Drivers* or driving forces (economic sectors, human activities), *Pressures* (e.g., emissions, waste, and land-use change), *State* (eg biological, physical, and chemical state, of the environment), *Impacts* (on ecosystem functions and public health), and *Responses* (prioritisation, target setting policies addressing ..). (EEA 1999).

It is adapted and promoted by the OECD for its environmental reporting, and adopted by several international organizations, such as US Environmental Protection Agency, UNEP, and the EU (Patrício Joana et al 2016) because it enables feedback to policy makers on environmental quality and the resulting impact of the political choices made.

Since its first design, this framework has been central to conceptualizing water risk analysis and risk management issues and then translating those for several stakeholders.

The underlining concept is that "pressures cause the changes to the system, the state changes are the unwanted changes and the responses are what society does to remove, minimize, or accommodate the changes. Hence, society has to be concerned about the risks to the natural and human system posed by those pressures (thus needing risk assessment) and then it is required to act to minimize or compensate those risks (as risk management)" (Patrício Joana et al 2016).

But describing the causal chain from driving forces to impacts and responses is a complex task, "as all the various cause-effect relationships have to be carefully described and environmental changes can rarely be attributed to a single cause". The process therefore tends to be broken down into several sub-tasks, e.g. by considering the pressure-state relationship and associated to indicators to understand the efficacy or sustainability of management actions.

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This is in line with the project purpose that aims to capture the contribution that farming system can have on water management in different climatic conditions, different types of farming systems, different legal frameworks, larger and smaller water collection areas.

2.2 OECD framework

To assist policy makers in addressing the water governance challenge, OECD proposed indicators and analysis to contribute in formulating policy responses that will move agriculture towards the sustainable management of water. An inventory of water governance indicators and measurement frameworks is available on the OEDC website which list indicators, databases, guidelines, maps, and assessment frameworks on measuring water governance (https://www.oecd.org/cfe/regional-policy/oecd-water-governance-indicator-framework.htm)

This project was developed by the OECD Centre for Entrepreneurship, SMEs, Regions and Cities as part of the 2017- 18 programme of work of the Regional Development Policy Committee. The indicator framework was produced through a bottom-up and multi stakeholder process within the OECD Water Governance Initiative over 2015-17.

In the last OECD paper published "Navigating pathways to reform water policies in agriculture" (Gruère, 2019) a *theory of change* is developed that emphasises the importance of flexibility in the timing and design of reform processes to achieve practical and effective policy changes.

More in detail the report identifies four challenging policy changes: charging water use in agriculture; removing subsidies that negatively impact water resources, regulating groundwater use and addressing nonpoint source pollution.

The report also highlights that agriculture policies are designed to affect multiple individuals with heterogeneous, often seasonal and market-dependent activities, with various landholding and income sizes and identify three types of **information problems** that may constrain the design and implementation of policy changes. The knowledge of these problems represents an important point of analysis and point of reference for the work of this task and are listed below as stated in the report:

- ***Imperfect information***: It is difficult to monitor water resources, water use, and water quality impacts for all farms.
- ***Information asymmetry***: Farmer characteristics are not known to administrators or regulators, and farmers know more about surface or groundwater use and polluting activities than administrators or regulators.
- ***Co-ordination failure***: Efforts by individual farmers to improve their management of water may not lead to measurable results at the watershed level unless others undertake similar efforts. However, co-ordinating efforts may be difficult due to incentives not to participate in improving management (free riding), significant time lags between efforts and outcomes, hydrological context, and differences in agricultural activities.

Without going into the details of the conditions deemed necessary to manage the water governance reform process, to which we suggest to refer to the original text, what we want to

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highlight for the purpose of our research, is that, despite the limits mentioned above, the report indicates that to reach the scope of policy change, water and agriculture policy reforms should be supported by an assessment of the context. This requires that all environmental, agronomic and economic concepts are well defined, and that objectives and evaluations are based on robust evidence.

To monitor and evaluate progresses towards the objectives, design of performance indicators or evaluation criteria is suggested. The metrics should be particularly sensitive and should reflect the policy objectives as much as possible. Therefore it follows that problem formulation at the beginning of the process and well defined objectives are of great importance

2.3 The FAO Sustainability Assessment of Food and Agriculture Systems - SAFA

SAFA is a holistic global framework for the assessment of sustainability along food and agriculture value chains, result of five years of participatory development, together with practitioners from civil society and private sector. Guidelines and tools for the calculation and application of the framework were developed, and hosted, by FAO for assessing the impact of food and agriculture activities on the environment and people. Was developed as "an international reference document, a benchmark that defines the elements of sustainability and a framework for assessing trade-offs and synergies between all dimensions of sustainability."
This framework is not focused on water. Compared to other sustainability analysis programs that mainly focus on the environmental impact of a product through its lifecycle, the FAO SAFA framework has the focus on supply chains and the evaluation of enterprise(s) in those supply chains. The concept that underline that choice is that "the focus on an enterprise rather than a product enables a more comprehensive consideration of good governance and social well-being components of sustainability".
An inventory of all the work done after 5 years of participatory development is available on the FAO website which list indicators, guidelines, tools and small holdersapps (http://www.fao.org/nr/sustainability/sustainability-assessments-safa/en/).
The framework is considered for the project as, acknowledging that there are many definitions of sustainability, depending on values, power relationships, time and space considered, SAFA offers a common framework for measuring performance according to core sustainability pillars following a well recognised hierarchical level. The highest level, refer to overarching pillars of sustainability. As these aspect are broad and encompass many aspects, they are declined through themes and sub-themes for each of the sustainability pillars. Goals are established for the themes while objectives are defined for the subthemes. These are measurable and verifiable through indicators .

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European Standards and projects

2.4 The European Water Stewardship (EWS) standard

This standard has been developed within the stakeholder process coordinated by the European Water Partnership (EWP).

It operates within the context of EU Policy and will ultimately contribute to implementation of the EU Water Framework Directive and to achieve The Water Vision for Europe 2030.

The EWS standard aims to be applicable to a broad range of water users that may affect the availability and quality of water and aims to give indicators for the whole water cycle: from extraction to re-allocation

The sustainability principle that EWS defines are summarised below:

- Achieve and maintain sustainable water abstraction in terms of water quantity
- Achieve and maintain good water status in terms of chemical quality and biological element
- Restore and preserve water-cycle related High Conservation Value (HCV) areas
- Achieve equitable and transparent water governance

This standard was originally designed mainly for certifications purpose; to verify the compliance in respect of a data set and in order to verify the progress and the willingness to improve the situation compared to a baseline.

2.5 OPERA approach

The fundamental focus of OPERA is to use the potential of existing scientific researches and knowledge to support the stakeholders in their political and technical decisions concerning agriculture, and the management of agricultural risks related to pesticides and the environment.

After an EU-wide consultation, drawing on experts from the fields of agriculture, industry, trade, academia, environment and consumers, OPERA research centre produced a document with the aims to supports the transposition process of the Directive and the drafting of National Action Plans as requested by the Directive 128/2009 on Sustainable Use of Pesticide (SUD).

It focuses on the proposal of a package of national indicators of risk, practical measures and the potential benefit they have in meeting the objectives of the SUD.

The toolbox of practical risk indicators developed within the stakeholder process proposed by OPERA facilitates positive pragmatic measures and set several criteria:

- it is important to clearly define goals and instigate measures to reach these goals.
- indicators are expected to help national regulatory bodies to assess trends in water quality and quantity and to judge the effectiveness of their programmes.
- the choice of measures, approaches and possible solutions is inextricably linked to the indicators selected. Therefore, the two topics - indicators and measures - have to be addressed in parallel

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- indicators selected should reflect a minimum number of economic, social and environmental aspect

2.6 The FLINT project (Farm Level Indicators for New Topics in policy evaluation)

The project shows how policy analysis could benefit from additional data with indicators on the sustainability performance of farms.

In the results/public library section of the project, (https://www.flint-fp7.eu/Database.html), a comprehensive database and documents with literature review on indicators, overview of sustainability indicators based on international literature and national initiatives, selection of farm level indicators and other topics as technical innovation, efficiency, etc., are available. Among this a report is provided that investigate relations and link between water usage, source and sustainability using information available in the Farm Accountancy Data Network (FADN) as location of the farm in a Water Directive Area, Irrigation system linked to irrigation governance and efficiency, cost of water and UAA of irrigated area per crop, completed with data collected in the project.

Indicators used in the case studies use quantitative and qualitative data. Some of them are simple, other composite. As reported in the project report *Farm-level indicators for evaluating sustainability and emerging new policy topics* "Simple indicators are based on one or a simple combination of variables of the same dimension. Complex indicators require more data, in particular environmental indicators. Simple indicators may be aggregated using knowledge on processes to generate proxy emissions or state indicators, which can be related to performance."

A crucial observation of the project is that, although the environment and other public values are the objectives of the policy, governments target a change in farm management. Therefore policy analysis requires an integrated data set at farm level to understand choices by farmers including trade-offs between economic and (sometimes contradicting) environmental and social objectives.

2.7 the Autograssmilk project.

the project Autograssmilk is financially supported by the European Community under the Seventh Framework Programme for under grant agreement SME-2012-2-3148. Even if the focus of the project is not water, we judge it relevant for our task for the output of the research that highlighted the importance of a clear and transparent "problem formulation" at the outset of the evaluation process, in the paper "The Choice of the Sustainability Assessment Tool Matters: Differences in Thematic Scope and Assessment" (Evelien M. de Olde et al., 2017)

In details the paper analysed the thematic scope of four sustainability assessment tools : RISE (Häni et al.,2003), SAFA (FAO, 2013a), Public Goods (PG) (Gerrard et al., 2012), and IDEA (Zahm et al., 2008), and compared the assessment results to make an in-depth comparison of tools with similar characteristics (i.e. focusing on indicator based farm level assessment, covering economic, environmental and social indicators, and suitable for livestock and arable farming).

To analyse the diversity in indicator-based sustainability assessment tools the following criteria were used: the assessment tool is focused at farm level, published by the tool developers in a peer-

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reviewed scientific journal or report, covers economic, environmental and social indicators, is suitable for livestock and arable agriculture in North-West Europe, is applied in multiple countries to enable contextualization and available in English.

Results show a strong variation between the outputs and approaches of methods. Tool developers select different (sub)themes and indicators, and apply different methods for measurement and aggregation of scores.

The conclusion is that variability in approaches results not only in different tools, but can also result in different conclusions on the sustainability performance of farms.

Using sustainability assessment tools to support farmers and policy makers in their decision making requires an in-depth understanding and discussion of the underlying decisions and assumptions, and their implications for the assessment results. This requires a high level of transparency in decisions made in the development of sustainability assessment tools.

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3 - The Indicators Toolbox

3.1- Background

We can find a lot of definitions in the literature about indicators, its purposes and the variety that can be used. An indicator might be simply defined as the "first, most basic tool for analysing change in the society" (Segnestam L., 2002).

The information generated by an indicator could be very useful to achieve several objectives (Gabrielsen et al., 2003) as:

- To supply information on environmental, economics and societal problems, in order to enable policy-makers to evaluate their seriousness;
- To support policy development and priority setting, by identifying key factors that cause environmental and societal pressure;
- To monitor the effects and effectiveness of policy responses, and
- To raise public awareness on specific issues.

To achieve all these objectives an indicators must meet some general criteria or requirements, (OECD 2003), (Segnestam L., 2002), (Dubus et al., 2006) as:

- *policy-relevant*– they should be implemented to address key environmental/social/economic issue either by governments, either by the other stakeholder in the agriculture sector.
- *analytically sound* – based on sound science in order to be theoretically well founded in technical and scientific terms. This requirement is fundamental to obtain a consensus about its validity.
- *measurable – feasible* in terms of current or planned data availability and cost effective in terms of data collection;
- *easy to interpret* – the indicators should communicate essential information to policy makers and the wider public in a way that is unambiguous and easy to understand. In this sense could be useful to have a threshold or reference value against which to compare it, so that users can assess the significance of the values associated with it.

Of course, "these criteria describe the ideal indicator, and not all of them will be met in practice" (OECD 2003). However, it is important to describe them in order to well identify the important benefits on using this important tool.

Why a toolbox?

Indicators are complex to design and explain. There is a need for a toolbox of indicators offering a certain degree of flexibility to adjust for specific conditions on the one hand, while ensuring a common and consistent approach (i.e. covering uniformly all the Action Labs in the Water Protect despite their differences and specificieties) on the other.

Sustainability assessment generally involves dividing the individual dimensions of sustainability into various issues of concern called objectives, attributes or themes and assessing these objectives using indicators.

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In more details in literature, indicator-based sustainability assessment tools are generally structured using three or four hierarchical levels. The highest level, represent the general dimensions of sustainability in other terms "the boundaries" of the thematic scope. These are translated into the sustainability pillars, through themes and sub-themes and finally, indicators provide information on the status of a (sub)theme (Evelien M. de Olde, 2017). A list of potential indicators can be collected through literature review, databases or expert consultation. To select indicators, criteria for indicator selection should be defined (Bockstaller et al., 2008, and 2009).

3.2 Toolbox Rationale

In the WaterProtect toolbox , indicators are grouped by issue or concerns, thus creating an appraoch that is above all easier to use.

These issues of concern correspond to the topics required by the project
1-water quality and quantity issues including pressures arising from agriculture
2-uptake of best management practices in agriculture;
3-sustainability of water management approaches;
4-role of land management decisions in water quality

Taking into account the specific requirements of the project, we propose to follow a hierarchical level as described below.

For each **topic** identified in the DOW, that represent the "boundaries" of the toolbox, it has been identified (see figure 2) the:

- **objectives** intended as sustainability objectives specific to the water management in agriculture or, in deep description of the issue that must be addressed for each topic (eg: for TOPIC 1 *Water quality and quantity issues including pressures arising from agriculture* we have 2 Objective: quality and quantity)
- **goals** intended as "*what is*" necessary to be addressed in order to reach the objective. These include the Principle defined in the EWS approach:
  - Achieve and maintain sustainable water abstraction in terms of water quantity
  - Achieve and maintain good water status in terms of chemical quality and biological element
  - Restore and preserve water-cycle related High Conservation Value (HCV) areas
  - Achieve equitable and transparent water governance
- criteria **or measures,** linked to specific indicators taking into account environmental, social and economic aspects, intended as *"how"* is necessary to reach the goal

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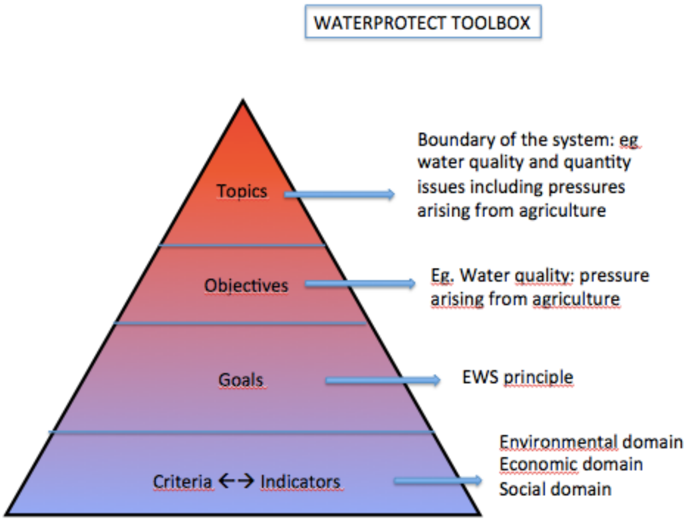

Fig.2 Adapted hierarchical level of the WaterProtect Toolbox from SAFA (FAO 2014)

If to be applied in the WaterProtect project, the subject of the evaluation ("*who?*") in this task is **the action lab** and data should be available in each action labs.

Indicators applicable and relevant at action labs level will measure:

Effectiveness : eg improvement of water quality as monitoring data for pesticide and nitrates in all labs that can be used to evaluate the time trends

Relevance : eg evaluation of the contribution of a strategy or a mitigation measure to reaching a goal as selection of the most appropriate measures that will deliver the greatest benefit

The toolbox could include also information on actions needed to achieve compliance with the indicator and/or points for improvement or extra information that can be provided to improve commitment beyond basic compliance with the indicator

This proposal allows us to respect the project's requests in terms of :

- **BUILD ON EXISTING TOOLS and EFFICIENCY:** making the best use of existing data from other frameworks, Labs and auditing systems. The sustainability principles that EWS defines are respected and included in the toolbox as the criterions and indicators
- **ADAPTABILITY and PERFORMANCE-ORIENTATION:** the objectives are common for each Labs but we have to ensure enabling different approaches and uses. General focus of the project is drinking water, labs do not have the same drinking water sources as focus of analysis, and same crops. Some crops are economic crop using minimal water (as wine for example) other traditional high-water demand cropping. Since the project aims to work on contextualization (and indeed proposes 7 different case studies), we propose a common and consistent method of analysis for all, but which allows a certain level of flexibility due to adaptation to the specific conditions.
- **IMPROVEMENT** tool to assess performance and identify areas for improvement**.**

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3.2 Material and methods for indicators selection

To provide a list of indicators addressing the contribution of farming system on water management and the pressure of agriculture on water quality a step wise approach was adopted.

3.2.1 Step 1 - first elicitation process

- Step 1 - Indicators proposal

Selection of indicators from the EWS standards (DOW requirement)

First elicitation

Collaborative action between each action labs for a common understanding. In this phase action labs leaders were inviting to discuss the list of indicators proposed, and received a table, which was filled in firstly from their perspective and expert judgments regarding:

Relevance – Availability of data- Metrics/Units –Scale.

Guidelines aimed to an explanation and for a better understanding of indicators proposed were submitted. More clarity was required on the background of the EWS standards, objectives and users by action labs leaders, in order to understand better the indicators selected.

A comparison between Waterprotect and EWS standard objectives and user was then produced as described in the tables below (tables 1, 2 and 3) to help in the selection of indicators, the evaluation of their usefulness, quality and reliability for the calculation of the EWP indicators at context level, to make a further screening, and to progress in the process.

Table 1 EWS standards and Waterprotect background

Objectives of European Water Stewardship From The European Water Partnership Standards document version: October 2017	**Objectives of Waterprotect toolbox** From DOW of the project
To assess sustainable water use	To capture the contribution that farming system can have to the sustainable management of water resources respecting the project's requests to build a toolbox of indicators in terms of: • best use of existing data • common objectives for each Labs but ensure enabling different approaches • to assess performance and identify areas for improvement
To build positive incentives to promote a change in behaviour and practices of water use, management and governance	To evaluate the relationships between the application of nitrate and pesticides (and their relevant metabolites) and their occurrence in

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	drinking water intake. to contribute to the effective uptake and realisation of innovative farming systems delivering good water quality
To provide a tool to achieve integrated sustainable water (resource) management	To provide indicator on: fertiliser and pesticide use and emissions (pressures); water quality (state and impact) through the participatory monitoring; costs and benefits (response).
To optimize the use of water on operational and river basin basis	To build upon existing and further develop a set of synthetic and easy to use indicators related to: the sustainability of water management approaches; uptake of best management practices in agriculture; role of land management decisions in water quality, water quality and quantity issues including pressures arising from agriculture.
To provide a tool for water users to demonstrate corporate responsibility	out of scope
To prepare the private sector for the implementation of the European Water Framework Directive	out of scope
To support water users in general to communicate and report on their water use.	Out of scope
To evaluate the use of water pertaining to a local and business basis.	Out of scope
To establish legitimacy via a third party verification of the water user's compliance	Out of scope

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Table 2 EWS standards and Waterprotect users

For whom is this standard applicable? ***EWS Standards***	***For whom will the toolbox be applicable?*** ***Waterprotect***
The EWS standard aims to be applicable to a broad range of water users that may affect the availability and quality of water while still respecting the complexity of impacts linked to water use and therefore: -Comprises environmental, social and economic aspects -Is valid on global scale but based on local assessment with focus on Europe	Proposals will develop harmonised, transparent and understandable indicators to ensure reliable and comparable data in order to involve farmers and citizens. Proposals should fall under the concept of the multi-actor approach.
	This task will also look at how such indicators can be used to contribute to a broader sustainable water management in agriculture and will issue guidance or recommendations to that effect for stakeholders. The focus will be to produce a simple to use set of indicators which build further on the EWP indicators that are easy to communicate and use in participatory governance water processes with the involvement of farmers and citizens

Table 3 EWS standards and Waterprotect rationale

The EWS standard includes ⇒ 4 principles**,** which outline the overarching aims of the EWS Standard, and associated criteria 1-Achieve and maintain sustainable water abstraction in terms of water quantity 2- Ensure the achievement and maintenance of good water status in terms of chemical quality and biological elements. 3- Restore and preserve water-cycle related High Conservation Value (HCV) areas 4- Achieve equitable and transparent water governance ⇒ 15 criteria are further divided into	The waterprotect table of indicators includes: ⇒ 4 topics as in DOW 1-water quality and quantity issues including pressures arising from agriculture 2-uptake of best management practices in agriculture; 3-sustainability of water management approaches; 4-role of land management decisions in water quality ⇒ 5 objectives further associated to 11 criteria Objective 1: Sustainable management of Water Quantity

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indicators which shall be used to evaluate compliance with the principles and criteria. ⇒ 46 Indicators are classified as major indicator (SS) or minor indicator (S). This classification acknowledges that some indicators might require more time in order to achieve compliance.	Objective2: Sustainable Management of Water Quality Objective 3 Improvement of farms strategy linked to water resources quality Objective 4: Water Governance Objective 5: Improvement of Sustainable Water Management achieved on operational and River Basin level by implementation of BMPs and by innovation and development----(not associated to any indicators yet) The criteria are further divided into indicators The numbers of indicators will depend on the results of the elicitation phase.

3.2.2 Step 2 - second elicitation procedure and selection

Goal of the first elicitation phase was to share perspectives and knowledge, but not to produce a definitive outcome. A second round of opinions was necessary to refine the selection.

- Step 2 – Second elicitation

Action labs leaders' judgements and evaluation were combined interactively, to arrive at a collective decision and approval of the indicators list.
Actions:

Main outcome of the first elicitation was presented and first screening from the list of indicators proposed in the first step was done. The main subjects of the questions concerned the terminology, the data availability and the results presentation. All agree that comparison between action labs will be not possible. Thus, in order to implement harmonisation across action labs, it is important to identify and evaluate the criteria so as to allow the selection of the most appropriate ones. Of course, one indicator could be considered the best in one context, whereas another could be the most appropriate in another. However, it is important to identify a common way of thinking in making an evaluation.

⇒ Some indicators could be simplified and could benefit of the outcome available at action labs level provided by different WPs (data from water monitoring campaigns, risk map, bmps...etc) and usable to evaluate a performance or a time trend evaluation.

Related to water quality

Complete and up-to-date inventory of all used potential and actual pollutants for waterprotect is limited to pesticide and fertiliser.
The quality of the water regarding pesticide and nutrients is analysed, monitored and reported

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Related to BMPs

All the indicators listed are applicable at action labs level

⇒ Some indicators are evaluated relevant in the table because fit the general goals of action labs and are not deleted from the list. Otherwise they are judged difficult to be applied because data are not available or need time to produce, and the evaluation need a long term perspective.

⇒ Some indicators are defined as relevant in the table because they could fit the general goals of waterprotect project (as for indicators related to water quantity) and are not deleted from the list, but are out of scope of action lab. Also, in this case some proposed indicators could be applicable at different scale but in general the judgment is that data are not available or need time to produce them.

⇒ Some indicators seems relevant but not necessary for the waterprotect objective not relevant at all for all action labs, so the following were deleted from the initial proposed list.

Related to water quantity:

- Water losses are identified. Type and destination of losses are described
- Reuse of marginal waters
- Water consumption per unit of product is quantified
- Efficiency of irrigation system used
- Adoption of innovative irrigation techniques

Related to water quality

- The quality of the effluent discharged by the site is analyzed, monitored and reported; only when required: statutory monitoring reports are completed
- After the analysis of current effluents, the main pollutants and priority substances are identified and if possible quantified
- The eutrophication potential is identified and evaluated

Related to sustainability of water management

- Recycling is included in the water management strategy and the volume of recycled water is monitored
- Internal transparency: Sustainable water management is disseminated within the operation
- The (quantitative) relation of water and energy use is identified and optimize

At the end of the process the toolbox comprised 4 Topics, 4 Objective, 10 criteria with 31 indicators.

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3.2.3 Brief description of the indicators selected and proposed to the evaluation of action labs leaders

TOPIC 1: Water quality and quantity issues including pressures arising from agriculture
Objective 1: Sustainable management of Water Quantity

Goal: Achieve and maintain sustainable water abstraction in terms of **water quantity**

Criterion1 : Water abstraction shall be quantified and monitored by source
Knowing the volume of water withdrawn by source contributes to an understanding of the overall scale of potential impacts and risks associated with the water use. The total volume withdrawn could provides an indication of the farmers systems importance as a water user, and could provides a baseline figure for other calculations relating to efficiency and use.

Quantifying water use can also indicate the level of risk posed by disruptions to water supplies or increases in the cost of water. Some crops are economic crop using minimal amounts of water (as wine for example) other, are high-water demanding crops. Clean freshwater is becoming increasingly scarce, and can impact production processes that rely on large volumes of water. In regions where water sources are highly restricted, the organization's water consumption patterns can also influence relations with other stakeholders.

1-All sources used for water abstraction are documented (documentation regularly updated)
Report all water sources used by the farming system for abstraction. Self-supply sources: • Groundwater (specify renewable groundwater and fossil water). • Surface (fresh) water (including water from wetlands, rivers, lakes artificial surface water bodies). Alternative sources from public water system: • Municipal water (tap, drinking, supply water). • Other Indicate how regularly the documentation is updated. Units/Targets: - Number and description of sources used. - Number and description of abstraction points. Indicator: state indicator Outcome Complete list of all water sources (abstraction points): Results for participative process: Report Documentation or map of the site's boundaries.
2-The water volume abstracted from each source is quantified, and reported
Provide a general table including: • Different irrigated areas or crops. • Water use on a daily and monthly basis Units/Targets:

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For irrigated agriculture: • Type of crop. • Size (ha.). • Water volume used daily/monthly Impact and state indicator (quantitative and descriptive). The table for water accounting serves as basis for all further impact evaluations. Information on water abstraction volumes can be drawn from water bills, calculations derived from other available water data or (if neither water meters nor bills or reference data exist) the farmers own estimates Results for participative process: report, tables maps associated to data
3-Water sources are classified in terms of their sensitivity according to one or more of the following criteria:
• Abstractions from water bodies that are recognized by professionals to be particularly sensitive due to their relative size. • Whether the source is designated as a protected area (nationally and/or internationally) regardless the amount of abstraction. • Groundwater is considered as sensitive source per se. Units/Targets:List of source and their sensitivity. Indicator: Pressure and impact indicator (descriptive). Information on the characteristics of a water source or protected area can be obtained from local or national water-related ministries or government departments, or research such as environmental impact assessments. Wetlands listed accordingly to the Ramsar convention are listed under http://www.ramsar.org/cda/ramsar. At European level information is provided for each River Basin District in the River Basin Management Plan For each water source listed in indicator 1 indication is made on whether it is classified as sensitive per one of the listed criteria. In addition to the above, provide documentation which demonstrates ✓ that multiple sources have been consulted (i.e. specific local legislation). ✓ the level of protection. ✓ concrete commitment on the protection of these sensitive areas. Results for participative process: descriptive report
4-For each sensitive water source identified: **Suitable and relevant periods of water stress are defined and** **Periods of water stress to abstraction and discharge rates are linked**
Asses periods of water stress. Calculate whether the maximum abstraction coincides with periods of water stress of the source. Relate also the water discharge to water stress periods.

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Calculate maximum abstraction, e.g. 20-30% of the total water available in the source (if not defined in permits or if only annual average is defined) Units/Targets: - Periods of water stress (sensitive periods) - Maximum abstraction rate [m3/month]. Indicator: Pressure indicator (quantitative). For each of the water sources classified as sensitive in indicator 3: ✓ Indication of a meaningful period of water stress of the source. ✓ Identification whether period of maximum abstraction coincides with the period of water stress. In addition to the above: ✓ For sensitive sources, the abstraction volume during sensitive periods is known. ✓ Calculation of maximum abstraction from each of those sources. ✓ Water discharge relation to water stress periods. Results for participative process: descriptive report
5- The impact of abstraction is described (by source)
The description includes: ✓ Environmental impact (e.g. loss of wetlands, biodiversity, protected areas, reduction of environmental flow, desertification, seawater intrusion, changes in river morphology, decline in groundwater level, etc.). ✓ Socio-economic impact (e.g. water shortage, interruptions of water supply, restrictions, imports, etc.) and the regional population potentially affected downstream by water abstraction and discharge Units/Targets: - Percentage of water abstracted from sensitive sources (%). - Description of impact. Indicator: Pressure and impact indicator (descriptive). Results for participative process: descriptive report

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Criterion 2: Best irrigation practice Actions taken to improve water efficiency, reduce water losses and mitigate detected and potential impacts of water abstraction shall be described and implemented. Knowing these data could contribute to improve water efficiency, reduce water losses and mitigate detected and potential impacts of water abstraction

6-Action is taken to mitigate actual and potential impacts caused by water abstraction
Set goals to reduce water consumption: ✓ Implementation of innovative technologies to reduce water consumption. ✓ Adoption of innovative irrigation technique ✓ Water losses are identified. Type and destination of losses are described ✓ Reuse of marginal waters Units/Targets: List of actions. Indicator: Impact indicator (descriptive). Results for participative process: descriptive report

Criterion 3: Identification of High Conservation Value (HCV) areas could help to restore and conserve biological diversity and its other associated values in areas that are directly linked to its water-cycle.

7- HCV areas mapped in vicinity of the production site (including both sources and discharge points) within a radius of 25 km
25 km from site: sources and points of discharge to be considered. Examples: ✓ Wetlands. ✓ Lakes. ✓ Riparian zones. ✓ Aquifer (groundwater). ✓ Others. Units: Map of areas. Indicator: Pressure indicator (quantitative and descriptive). Information of HCV areas should be available in River Basin Committee authorities. It can also be found in the documentation of the farmers systems organisations, site plans, or organizational policies. Results for participative process: Provision of overview map with the HCV areas marked in radius of 25 km around the production site and around all sources and discharge points used.
8- The HCV areas are listed and protection goal(s) identified (e.g. flora and fauna, water quality, birds, bathing waters, recreational, etc.)
Examples: • Flora and fauna • Water quality • Birds

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- Biodiversity

Examples of other type values of water are recreational, religious, social, cultural. For instance:

- Drinking water protection areas.
- Spas protected areas.
- Bathing areas.
- Fishing reserve.
- Canoeing/kayak areas.

Units: Protection values.
Indicator: Pressure indicator (quantitative and descriptive).
Results for partecipative process
Provision of:
✓ Overview table with protection values of the HCV areas identified
✓ Qualitative description of protection values and targets.

Criterion 4 Transparency on economic aspects could improve to raise efficiency of water consumption. By asking for structured, qualitative information on productivity, the indicator enables a comparison across farming systems and over time of the relative size, scale and nature of water productivity.

9 Investments made by farmers for maintenance and improvement of the water management are fully reported.
Description of measures to ensure optimal water use maintenance and improvement, with updated evaluation results, monitoring strategy Units: list of action, investment Indicator Driver indicator (quantitative). Results for participative process Provision of: description of measure

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Objective2: Sustainable Management of Water Quality

Goal: Achieve and maintain good water status in terms of chemical quality and biological element

Criterion 5 : Water quality shall be determined, monitored and documented. Sustainable Water Management shall ensure the achievement and maintenance of the good water status, meeting legal and/or agreed quality standards in all affected river basins. By progressively improving the quality of water and/or reducing volumes, the farming system has the potential to reduce its impact on the surrounding environment

10 - Complete and up-to-date inventory of all used potential and actual pollutants
The aim is to have a detailed scenario. Depending on pollutant the inventory shall include a description of the pollutants per the following schemes: • Classified as hazardous to the Aquatic Environment (H-phrases). • Considered a main pollutant per the EC Water Framework Directive (2000/60/EC). • Considered a priority substance or specific pollutant in river basin per the EC Water Framework Directive (2000/60/EC). • Considered as pollutant by the local/national legislation Units/Targets: - Inventory, Indicating frequency and amount/volume applied Indicator: Pressure and state indicator (descriptive). Results for participative process ✓ List of all inputs.
11 - For each of the potentially polluting substances, the type of pollution (i.e. point of diffuse pollution) is described
For each of the substances report on potential type and source of pollution; i.e. point pollution, diffuse pollution Units/Targets: Inventory Indicator: Pressure and state indicator (descriptive) Results for participative process Report of: ✓ The type of pollution. ✓ Estimation of the potential destinations affected by pollution
12- The quality of the water is analysed, monitored and reported.
Report on the effluent water (discharged wastewater) analysis including type and amount of: • Hazardous substances. • Nutrients. • Pollutants.

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Units: Inventory, Quality data. Indicator: Pressure and state indicator (quantitative and descriptive) Results for participative process: provide information on regularly updated analysis. Maps associated with data. Graph with time trend chemicals/pollutants monitored
13 - After the analysis of current effluents, the main pollutants and priority substances are identified and if possible quantified
quantifies the substances concentration and the load (kg/year) Units/Targets: Concentration and load [kg/year] Indicator: Pressure and state indicator (quantitative and descriptive). General for farmers with diffuse pollution--> Get in contact with the local River Basin authorities to regularly update you on the quality of surrounding water bodies. In case main pollutants or priority substances are found which are used as well at your production site, act and verify whether this substance could be Results for participative process: Proof of monitoring, table, graphs

TOPIC 2: Uptake of best management practices in agriculture

Objective 3 Improvement of farms strategy linked to water resources quality

Goal : availability at the production site of water resources management strategy

Criterion 6 Sustainable use of pesticide at action labs level or catchment scale. Knowing basic quality analysis on best management practices implemented or with the potential to be implemented at action labs level could help to address a provision of action aimed to reduce the impact of the farming system on its surrounding environment and in general to improve the water management strategy.

14 - **Number of farms using WATERPROTECT selected pesticide best management practice/crop.**
Report the BMPs applied in the action labs area Units: list of BMS provided with survey interviews and questionnaires with farmers operating within case study areas Indicator: state indicator (quantitative and descriptive) Results for participative process: tables, graphs
15 - Percentage of farms where pesticide BMPs are implemented and BMPs with the potential to be implemented Report the BMPs implemented in the action labs area farms Units: list of BMS provided with survey interviews and questionnaires with farmers operating within case study areas Indicator: state indicator (quantitative and descriptive)

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Results for participative process: tables, graphs
16- Pesticide BMPs obligatory by law
Report the BMPs applied in the action labs area obligatory by law Units: list of BMS provided with survey interviews and questionnaires with farmers operating within case study areas Indicator: state indicator (quantitative and descriptive) Results for participative process: tables, graphs
17 - Percentage of farms willing to implement best management practice
Report the BMPs that have the potential to be implemented in the action labs area farms Units: list of BMS provided with survey interviews and questionnaires with farmers operating within case study areas Indicator: state indicator (quantitative and descriptive) Results for participative process: tables, graphs
18 - Incentive for the uptake of BMPs
Report the incentive available for BMPs potentially applicable in the action labs area farms Units: list of actions and measure within case study areas Indicator: state indicator (quantitative and descriptive) Results for participative process: descriptive report
19 - High risk areas are identified at the production site and indicated on maps
Map areas at the production site which pose high risk of water pollution. Note that in case there are wells in the area, these are major risk points for groundwater pollution and should be identified as such. Indication must be provided on how the well has been constructed and is sealed together with any precautionary measures in place to protect them. For agriculture: Areas with high risk of water pollution are characterized per their risk of leaching, erosion and run-off or drainage (e.g. regarding soil texture, organic carbon content, groundwater depth, subsurface material, slope, etc.). Units: - Map of areas with high risk of polluting. Indicator: Impact indicator (descriptive). Notes for runoff and erosion: Key Influencing Factors for diagnosing runoff and erosion: - Proximity to water course - Soil permeability - Topography - Weather patterns Provision of: Overview map of areas with high risk of polluting.

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Criterion 7 Sustainable use of fertilizer at action labs level or catchment scale**.** Knowing basic quality analysis on best management practices implemented or with the potential to be implemented at action labs level could help to address a provision of actions aimed to reduce the impact of the farming system on its surrounding environment and in general to improve the water management strategy.

20 - **Number of farms using WATERPROTECT selected best management practice/crop.**
Report the BMPs applied in the action labs area Units: list of BMS provided with survey interviews and questionnaires with farmers operating within case study areas Indicator: state indicator (quantitative and descriptive) Results for participative process: tables, graphs
21 - Percentage of farms where fertiliser BMPs are implemented and BMPs with the potential to be implemented Report the BMPs implemented in the action labs area farms Units: list of BMS provided with survey interviews and questionnaires with farmers operating within case study areas Indicator: state indicator (quantitative and descriptive) Results for participative process: tables, graphs
22- Fertiliser BMPs obligatory by law
Report the BMPs applied in the action labs area obligatory by law Units: list of BMS provided with survey interviews and questionnaires with farmers operating within case study areas Indicator: state indicator (quantitative and descriptive) Results for participative process: tables, graphs
23 - Percentage of farms willing to implement best management practice
Report the BMPs that have the potential to be implemented in the action labs area farms Units: list of BMS provided with survey interviews and questionnaires with farmers operating within case study areas Indicator: state indicator (quantitative and descriptive) Results for participative process: tables, graphs
24 - Incentive for the uptake of BMPs
Report the incentive available for BMPs potentially applicable in the action labs area farms Units: list of actions and measure within case study areas Indicator: state indicator (quantitative and descriptive) Results for participative process: descriptive report
25 - High risk areas are identified at the production site and indicated on maps
Map areas at the production site which pose high risk of water pollution.

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Note that in case there are wells in the area, these are major risk points for groundwater pollution and should be identified as such. Indication must be provided on how the well has been constructed and is sealed together with any precautionary measures in place to protect them. For agriculture: Areas with high risk of water polluting are characterized per their risk of leaching, erosion and run-off or drainage (e.g. regarding soil texture, organic carbon content, groundwater depth, subsurface material, slope, etc.). Units: - Map of areas with high risk of polluting. Indicator: Impact indicator (descriptive). Notes for runoff and erosion: Key Influencing Factors for diagnosing runoff and erosion: - Proximity to water course - Soil permeability - Topography - Weather patterns Results. Provision of: Overview map of areas with high risk of polluting.

TOPIC 3: Sustainability of water management approaches

Objective 4: Water Governance

Goal: Achieve equitable and transparent water governance. The farming systems shall achieve an equitable system for its water use, make its water management policy publicly available and raise awareness by pro-active measures. This principle refers explicitly to a 'continuous improvement' approach rather than a 'performance level' approach, unless additional minimum performance requirements are specified.

Criterion 8 : The water management shall ensure compliance with all legal requirements linked to water use

26-A person or department is identified who ensures compliance with legal requirements linked to water); **27- Procedures are established, implemented and monitored which ensure that legal aspects and compliance with the law of the production sites' water abstraction, reuse or discharge are entirely disclosed and kept up-to-date**
Identification of a responsible person or department In addition to above: Procedure on how new legal requirements (e.g. WFD – implementation) are prepared (for future perspectives). Demonstrate knowledge of pending legislation/requirements which might affect water-related operations

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Units: List of applicable legislation and person responsible for updating it. Indicator: Driver and response indicator (descriptive). Possible Results: List and description of all applicable water-related legal and regulatory requirements; Updated version of all permits linked to water management, list of name/contact or istitution responsable

Criterion 9 : integrated approach Water management taking the management of other resources into account

28- Environmental cost analysis in place
Identify prevention and environmental management costs based on expenditures related to the following items: ✓ **Personnel employed for education and training.** ✓ **External services for environmental management.** ✓ **Research and development.** ✓ **Investments in water saving programs and measures.** ✓ **Other environmental management costs.** ✓ **Environmental charges as percentage of water tariff.** Evaluation of current and future costs / investments towards the implementation of an efficient water use strategy. Report on how this costs analysis has been considered in decision-making. Units/targets: Cost related to environmental management, Water tariff. Indicator: Response indicator (quantitative and descriptive). Results: Descriptive Report

Criterion 10 : internal and external transparency and raising awareness. Understanding the catchment context in which the farming system operates is integral to successful water management activities, to give positive examples and to spread experience and expertise on Sustainable Water Management

29 -A person or department is identified who participates and qualitative reports on River Basin Committee activities
Person / department to represent and report on River Basin Committee activities is identified Identify water-related stakeholder challenges Unit: External communication tools. Indicator: Response indicator (descriptive). Results: Report
30- External transparency: The water management is publically available for customers, the public and authorities
reporting at least on:

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- ✓ Basic information on abstraction.
- ✓ Basic information on discharges.
- ✓ Information on improvement activities.

Extra information can be added on:

- ✓ Actions and achievements linked to sustainable water management.
- ✓ Definition of water-related risks and preventive measures implemented.
- ✓ The results of the water impact assessment are disclosed.
- ✓ The operational water resources management strategy.

Unit: External communication tools.
Indicator: Response indicator (descriptive).
Results: report

31 -Campaigns or partnerships to inform stakeholders on water topics are described and implemented

Consider:

- ✓ Frequency,
- ✓ Targeted audience.
- ✓ Type of information: on water or water-linked topics.
- ✓ Indicate how stakeholders have been selected

Unit: Number and type of promotion campaigns on water or water-linked topics performed per year.
Indicator: Response indicator (descriptive).
Result: List of campaigns to inform on water linked topics. (E.g. workshop on irrigation techniques, application of relevant best management practice).
In addition to the above:
Regular and active performance of activities within different forums / partnerships / associations in place to inform on water linked topics.
Evidence that a stakeholder analysis was performed to involve all stakeholders

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3.2.4 Step 3 - example of indicators application in the frame of the Waterprotect project

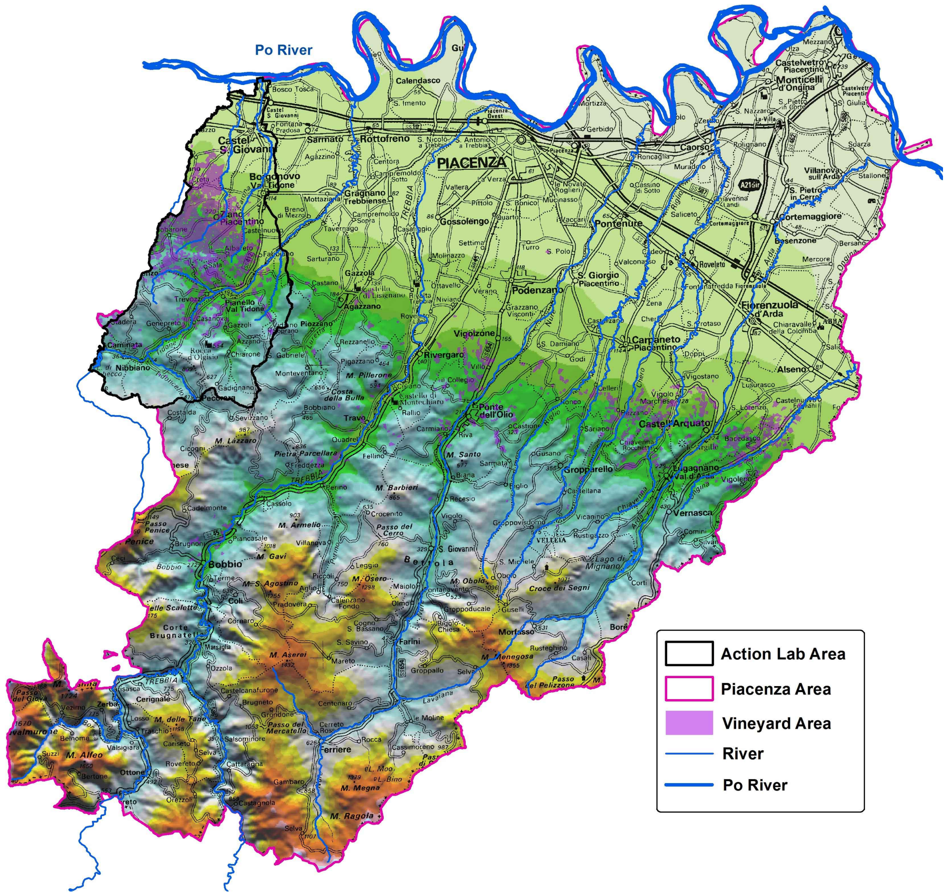
In order to confirm the applicability of the indicators prosed in the toolbox, examples are provided below, using the pesticide monitoring data coming from the WP3 Waterprotect project monitoring campaigns of the Italian action labs and Belgium Action Lab.

Objective2: Sustainable Management of Water Quality

Goal: Achieve and maintain good water status in terms of chemical quality and biological element

Criterion 5: Water quality shall be determined, monitored and documented. Sustainable Water Management shall ensure the achievement and maintenance of the good water status, meeting legal and/or agreed quality standards in all affected river basins. By progressively improving the quality of water and/or reducing volumes, the farming system has the potential to reduce its impact on the surrounding environment

Area of study : Val Tidone Catchment



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The Val Tidone Catchment (206.72 km2/ 455 farmers) is placed in the north-west of Italy in Emilia Romagna region and it is characterized by a mix of urban, peri-urban and rural areas. The area covers five municipalities: Ziano Piacentino, Castel S.Giovanni, Alta Val Tidone, Pianello, and Borgonovo for a total of 28548 inhabitants

Val Tidone represents a hilly zone characterized by an elevation level between 100 and 350 above sea level and it is known for the deeply rooted tradition and vocation to viticulture. The main culture is the vineyard, with 2941 Ha in year 2016 and the inhabitants of the rural villages are mainly involved in grape and wine production, organized as private farms or as social wineries.

The peculiar orographic features of the territory have determined the development and adoption of agricultural/hydraulic plumbing systems that represent a sort of mitigation measure applied in order to limit the erosion and control the water speed, slowing down the water flow that shapes hills, turning them into an orderly sequence of longitudinal line

Toolbox Indicators n.10 n.11 - Pressure Indicator

Inventory of **pesticides** used in the area subject of study. Provide data in the following table (table 1) on:

- frequency of application (eg 1/year) please write a brief note on how the data is calculated (eg.estimation from integrated pest management program, derived by label etc)
- amount/load (eg kg/ha) please write a brief note on how the data is calculated (eg.estimation from integrated pest management program, derived by label etc)
- type of pollution prevalent (point source (PS) /diffuse source (DS))
- Estimation of the potential destinations affected by pollution (Ground water (GW)/Surface Water (SW) /Soil (S))

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Table 1

Category: Pesticide	Frequency (max)	Amount	Estimation of the potential destinations affected by pollution	Detected in water monitored[d] (Yes/No)	Over the legal limits (Yes/No)	type of pollution prevalent*
Chlorpiriphos	1 per year[a]	360 g/ha[a]	GW	Yes	Yes	
Chlorpiriphos-methyl	1 per year[b]	230 g/ha[b]	GW	Yes	No	
Chlorantraniliprole	1 per year[a]	54 g/ha[a]	GW	Yes	Yes	
Cyflufenamid	2 per year[a]	25 g/ha[a]	GW	Yes	No	
Cyprodinil	2 per year[b]	300 g/ha[b]	GW	No	No	
Dimetomorph	3 per year[b]	250 g/ha[b]	GW	Yes	Yes	
Flufenacet	4 per year[a]	1.350 g/ha[a]	GW	Yes	No	
Fluopicolide	3 per year[a]	133 g/ha[a]	GW	Yes	Yes	
Isopropalin[c]			GW	No	No	
Metalaxyl-M	3 per year[a]	97 g/ha[a]	GW	Yes	Yes	
Metsulfuron-methyl	3 per year[a]	6 g/ha[a]	GW	Yes	No	
Penconazole	3 per year[a]	40 g/ha[a]	GW	Yes	Yes	
S-metolachlor	1 per year[a]	1920 g/ha[a]	GW	Yes	Yes	
Tetraconazole	3 per year[a]	30 g/ha[a]	GW	Yes	Yes	
Tribenuron-methyl	3 per year[a]	30 g/ha[a]	GW	No	No	

[a]The frequency and amount values derive from EFSA peer reviews
[b]The frequency and amount values derive from label.
[c]Revoked
[d]Sampling campaigns were made from November 2017 to September 2019
*The available data are not sufficient to provide this type of information

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Provide data in the following table (table 2)

- Classified as hazardous to the Aquatic Environment (H-phrases). (please insert **H**)
- Considered a main pollutant for the EC Water Framework Directive (2000/60/EC). (please insert **MP**)
- Considered a priority substance or specific pollutant in river basin per the EC Water Framework Directive (2000/60/EC). (please insert **PP**)
- Considered as pollutant by the local/national legislation (please insert NP)

Table 2

Category: Pesticide	Classified as hazardous to the Aquatic Environment	Classified as hazardous to human health	Considered a priority substance or specific pollutant in river basin for the EC WFD	Considered as pollutant by the local/national legislation
Chlorpiriphos	H400, H410	H301	PP	No
Chlorpiriphos-methyl	H400, H410	H317	No	NP
Chlorantraniliprole	H400, H410	H319, H335	No	No
Cyflufenamid	H400, H410, H411	H332	No	No
Cyprodinil	H400, H410	H317	No	No
Dimetomorph	H411		No	No
Flufenacet	H400, H410	H302, H317, H373	No	NP
Fluopicolide	H400, H410		No	No
Isopropalin	H400, H410		No	No
Metalaxyl-M		H302, H318	No	NP
Metsulfuron-methyl	H400		No	No
Penconazole	H400, H410	H302, H361d,	No	NP
S-metolachlor	H400, H410	H317	No	No
Tetraconazole	H411	H302, H332	No	NP
Tribenuron-methyl	H400, H410	H317, H373	No	No

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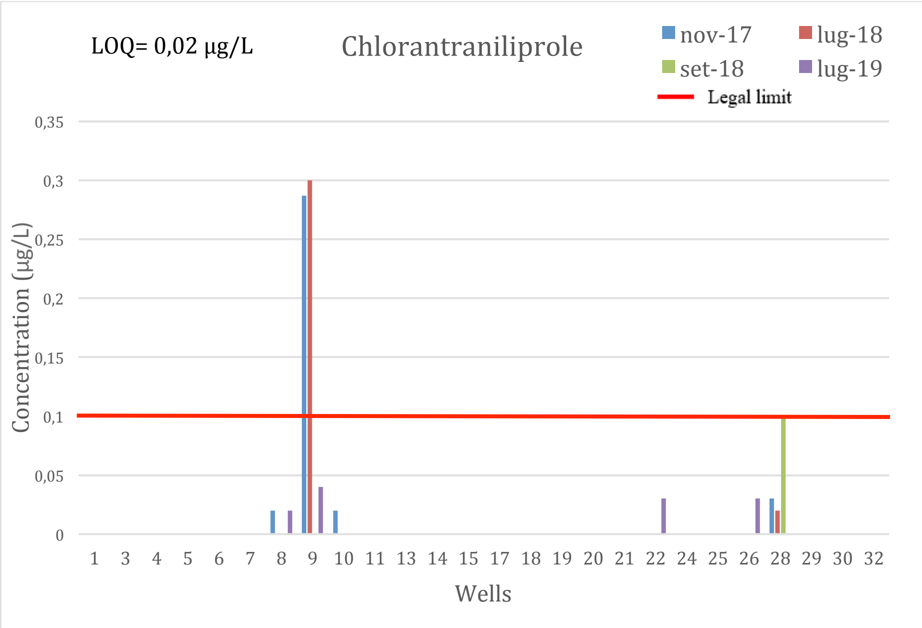
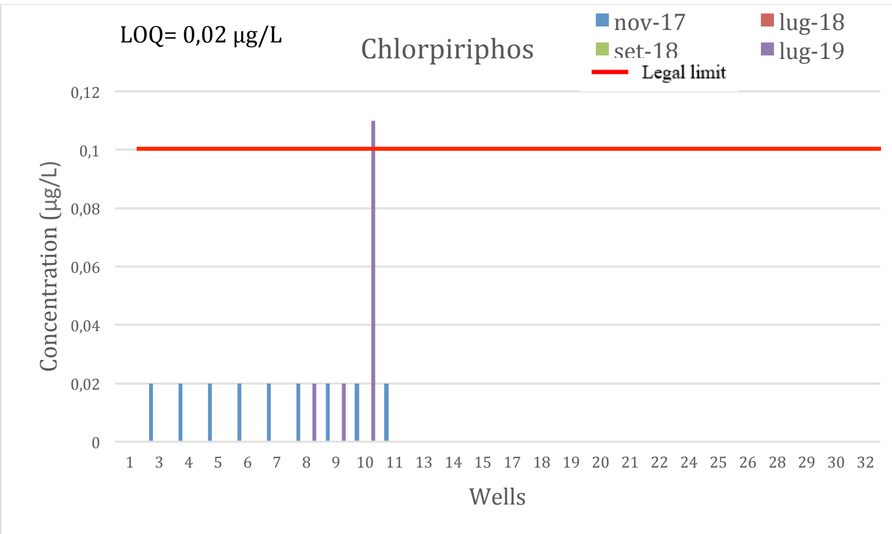
Toolbox Indicators 12-13 - State Indicators:

Provide data on Monitoring and analysis results.

1-Graph with time trend chemicals/pollutants monitored





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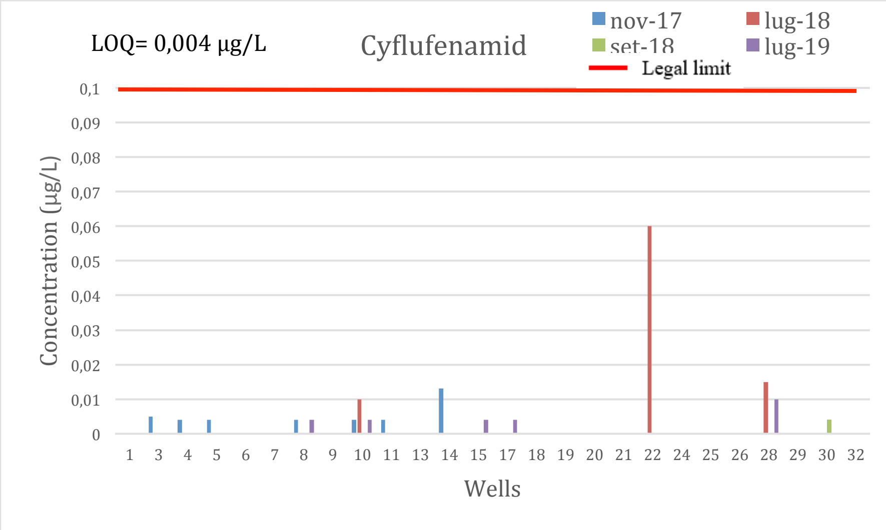

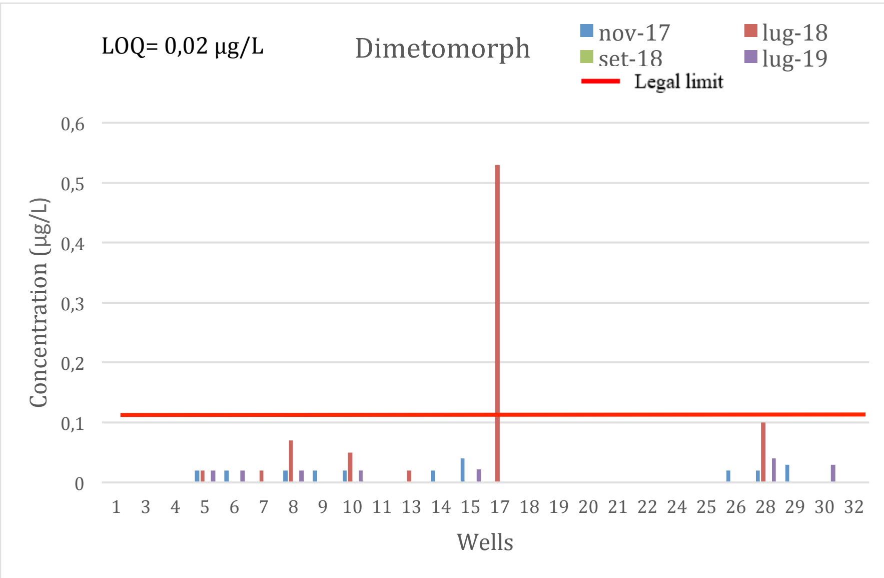

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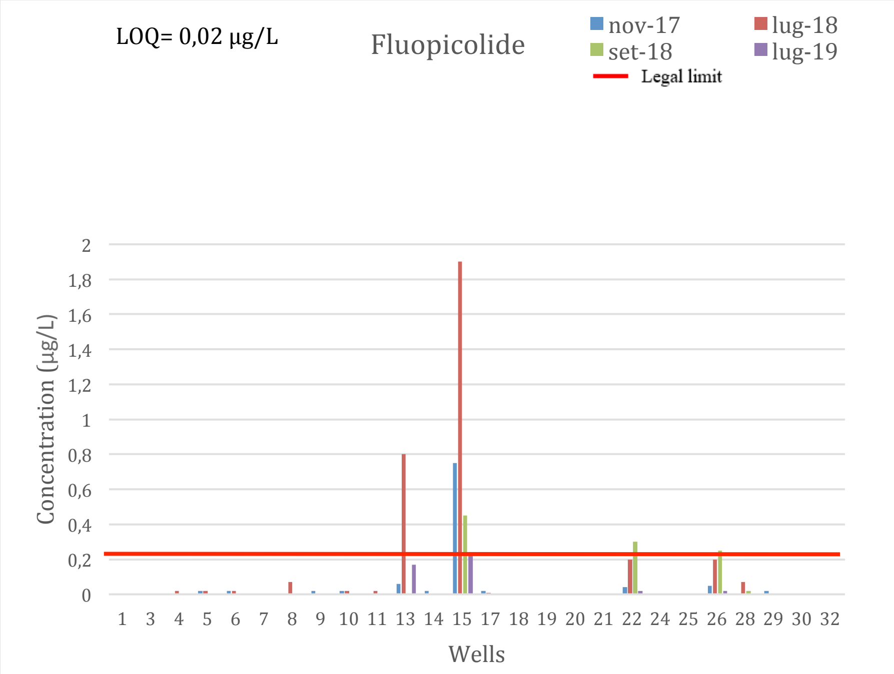

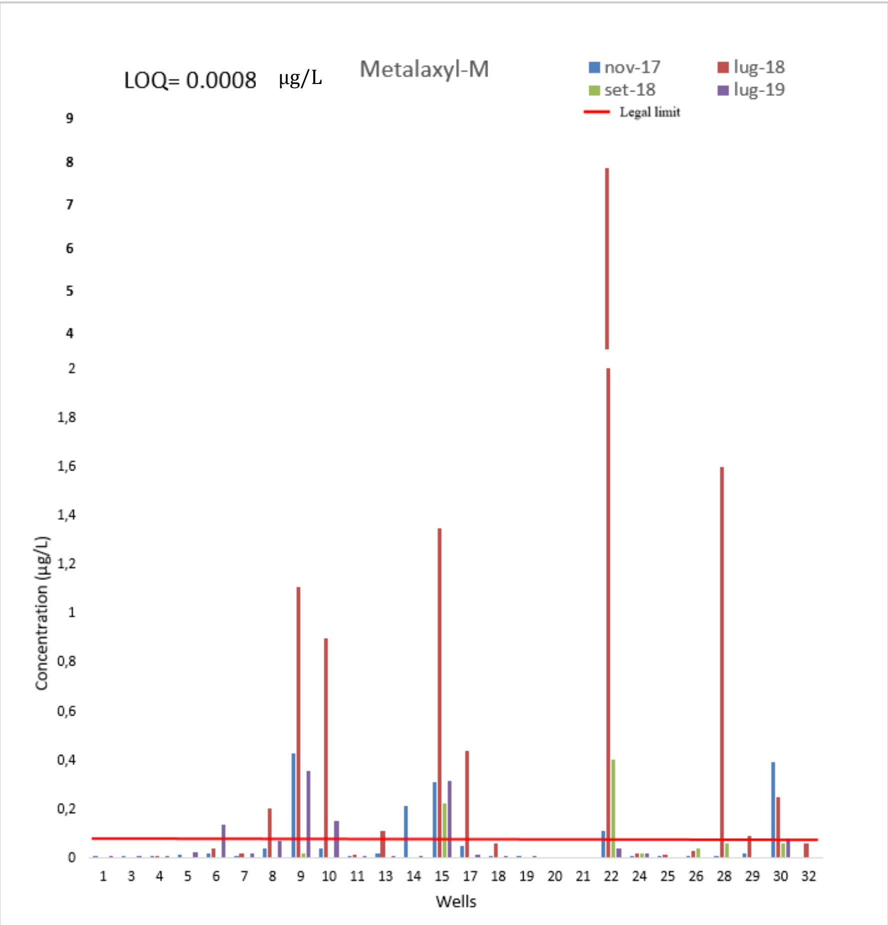

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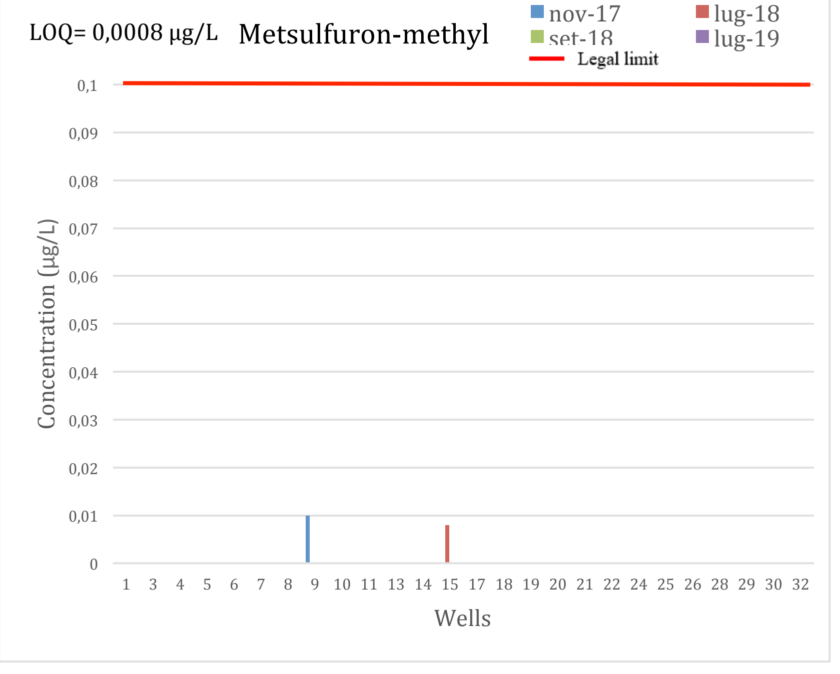

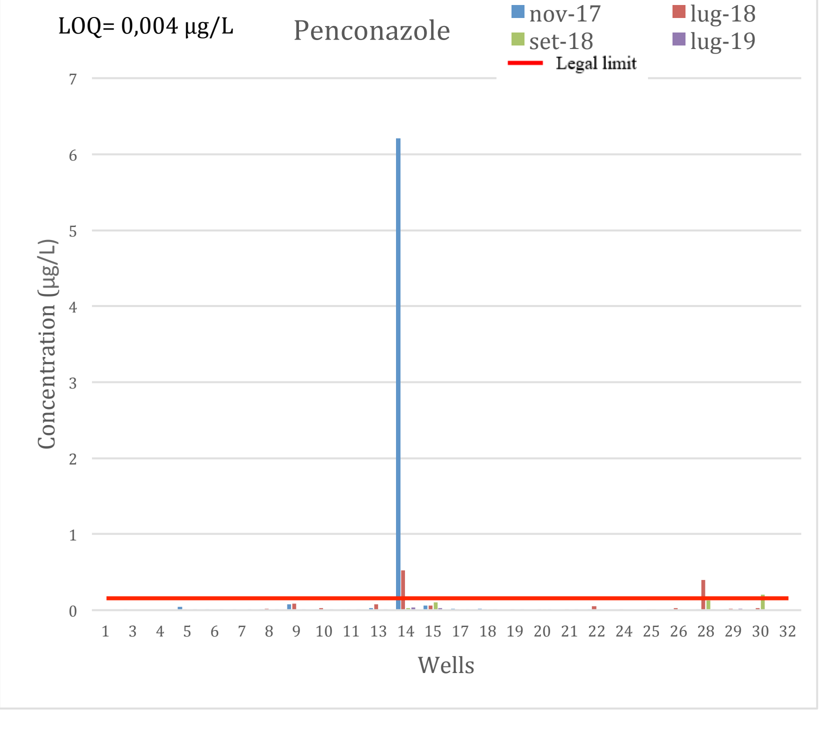

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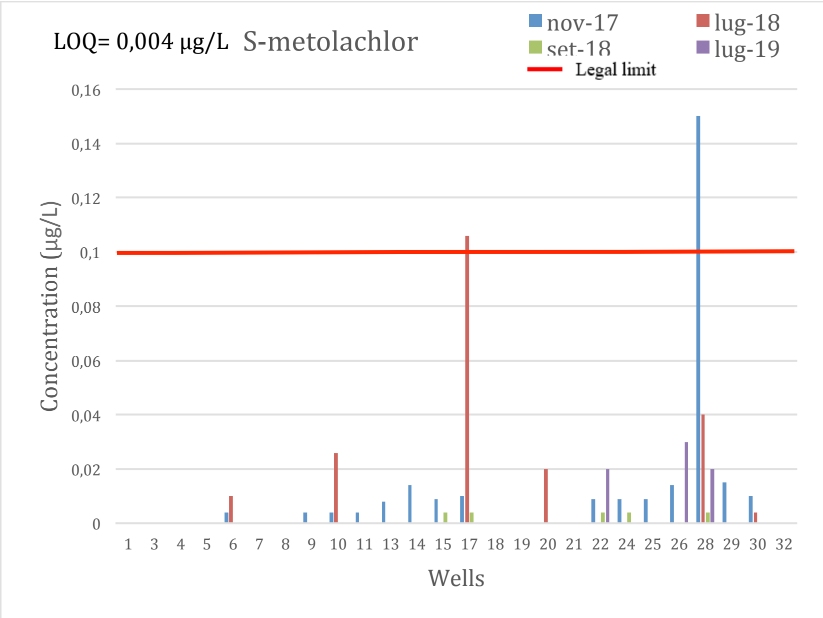

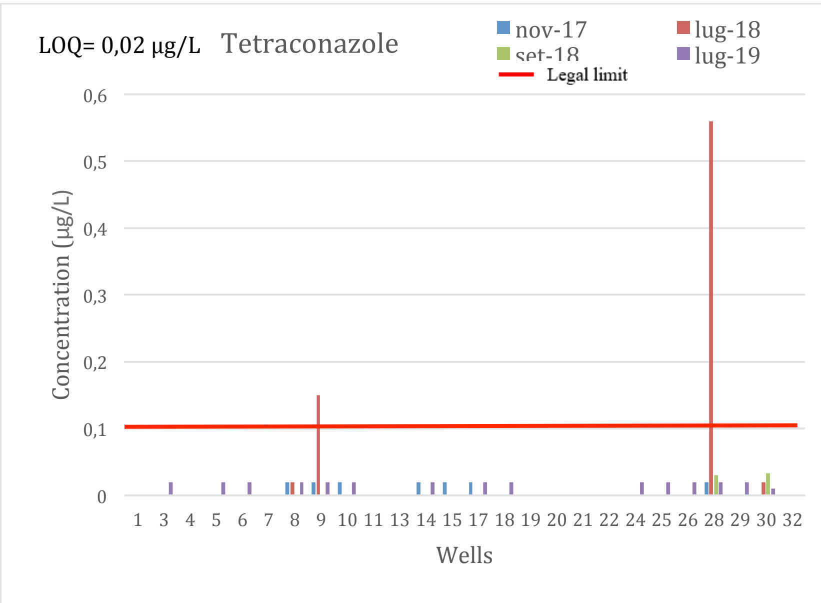

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Brief results discussion

Based on the results shown in the graphs, it is clear that there is an impact of grape cultivation on groundwater quality. However, the concentration of pesticides in groundwater seems to decrease over time indicating that the actions taken to improve the water governance in the action could have a positive impact on decreasing the vulnerability of groundwater towards pesticide pollution. Indeed, several awareness campaigns with farmers and other actors involved in water use and governance were specifically performed to increase them knowledge and understanding concerning groundwater quality. Furthermore, this helped the Italian partners involved in the project to understand how important is to define communication and awareness raising context specific campaigns. Furthermore, the mitigation measures that will be implemented will lead to an overall improvement of the groundwater quality. In light of this, it is possible to conclude that context monitoring study is essential in order to understand if there is an environmental impact and consequently operate to prevent environmental pollution.

2-Maps associated with data (if available and to be considered in a participative process)
The map is available on the WaterProtect platform at this link: https://waterprotecteu.marvin.vito.be/
The study area is Val Tidone Italy. This work is part of the Working Package 5, which concerns the development of a GIS platform in which is possible to consult the results of the monitoring studies.

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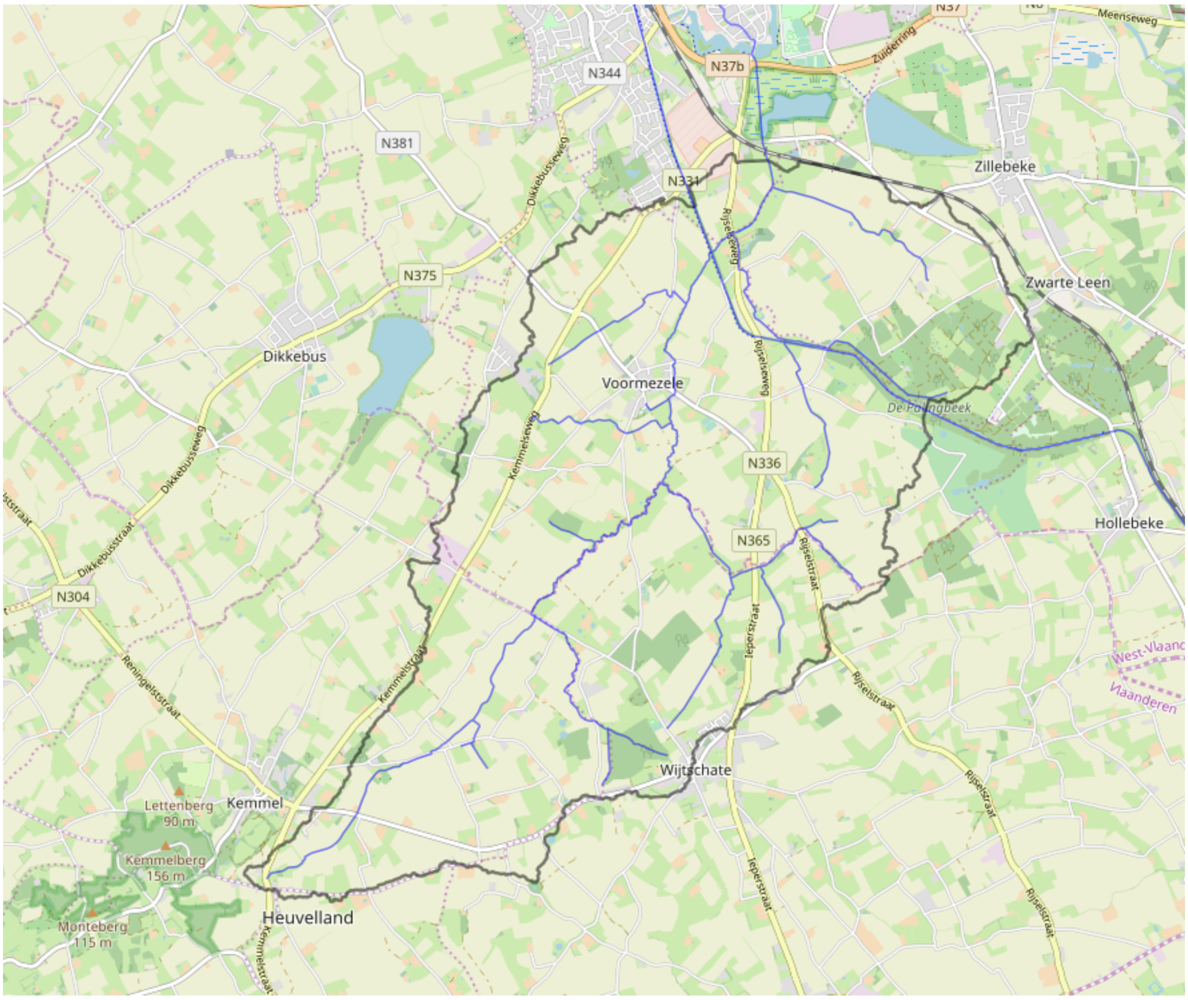
Area of study: The Bollaertbeek catchment



The Belgium Action Lab is situated in the west of the country, in the province of West Flanders. The study area includes small villages of Voormezele and Wijtschate and parts of Kemmel and the city of Ypres. The study area has a surface of 22,6 km² of which 81% is used for agriculture (1907 ha). The Bollaertbeek catchment has a mixed urban and rural land-use. There are 164 farmers having their fields in the study area.

The Bollaertbeek catchment is a part of the surface water capturing area of the drinking water production company 'De Watergroep'. They abstract water at the outlet of the Bollaertbeek catchment to produce drinking water. Water is also used by farmers to irrigate their parcels, to fill and clean their sprayers and as drinking water for their animals.

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Toolbox Indicators n.10 n.11 - Pressure Indicator

Inventory of **pesticides** used in the area subject of study. Provide data in the following table (table 3) on:

- frequency of application (eg 1/year) please write a brief note on how the data is calculated (eg.estimation from integrated pest management program, derived by label etc)
- amount/load (eg kg/ha) please write a brief note on how the data is calculated (eg.estimation from integrated pest management program, derived by label etc)
- type of pollution prevalent (point source (PS) /diffuse source (DS))
- Estimation of the potential destinations affected by pollution (Ground water (GW)/Surface Water (SW) /Soil (S))

table 3

Category: Pesticide	frequency	amount	Estimation of the potential destinations affected by pollution	Detected in water monitored (Yes/No)	Over the legal limits (Yes/No)	type of pollution prevalent
Bentazone	Max. 960 g bentazon/ha/ year (from label)	Max. 2 L/ha for peas from product containing 960 g/ha a.i. (from label) but this is dependent of the crop	SW*	Yes	Above WQS, but not above EQS	PS/DS
Chloridazone	1 application for sugar beet (from label) but this is dependent of the crop and the dose	3,1 – 5 L/ha for sugar beet from product containing 520 g/ha (from label) but this is dependent of the crop	SW*	Yes	Above WQS, but not above EQS	PS/DS

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dimethenamide	max. 1 kg/ha/12 month (from the label)	1.4 l/ha for corn from product containing 720 g/L a.i. (from the label), but this is dependent of the crop	SW*	Yes	Yes, above WQS and EQS	PS/DS
MCPA	Max. 1 appl/12 month (from the label)	4 L/ha for grass for product containing 200g/L a.i. (from label) but this is dependent of the crop	SW*	Yes	Yes, above WQS and EQS	PS/DS
S-metholachlor	max. 1-2 appl./year or max. 1,5L/ha/12 month dependent of the crop (from the label)	1,5 L/ha for corn for product containing 960 g/L a.i. (from label) but this is dependent of the crop	SW*	Yes	Yes, above WQS and EQS	PS/DS

*SW is known. The other destinations are not taken into account into the project and not known.

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Provide data in the following table (table 4)

- Classified as hazardous to the Aquatic Environment (H-phrases). (please insert **H**)
- Considered a main pollutant for the EC Water Framework Directive (2000/60/EC). (please insert **MP**)
- Considered a priority substance or specific pollutant in river basin per the EC Water Framework Directive (2000/60/EC). (please insert **PP**)
- Considered as pollutant by the local/national legislation (please insert NP)

Table 4

Category: Pesticide	Classified as hazardous to the Aquatic Environment	Considered a main pollutant per the EC WFD*	Considered a priority substance or specific pollutant in river basin per the EC WFD*	Considered as pollutant by the local/national legislation
Bentazone	H	No	No	NP
Chloridazone	H	No	No	NP
dimethenamide	H	No	No	NP
MCPA	H	No	No	NP
S-metholachloor	H	No	No	NP

Toolbox Indicators 12-13 - State Indicators:

Provide data on Monitoring and analysis results

Graph with time trend chemicals/pollutants monitored

Bentazon: https://waterprotecteu.marvin.vito.be/substance-analysis/limit/drinking_water_limit_single_value/substance/9/1

Chloridazon: https://waterprotecteu.marvin.vito.be/substance-analysis/limit/drinking_water_limit_single_value/substance/13/1

Dimethenamide: https://waterprotecteu.marvin.vito.be/substance-analysis/limit/drinking_water_limit_single_value/substance/23/1

MCPA: https://waterprotecteu.marvin.vito.be/substance-analysis/limit/drinking_water_limit_single_value/substance/31/1

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Metholachlor: https://waterprotecteu.marvin.vito.be/substance-analysis/limit/drinking_water_limit_single_value/substance/39/1

2-Maps associated with data (if available and to be considered in a participative process)

See links above. Maps with the measuring points and the number of exceedance of the limits are also available.

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4-Recommendations for the use of indicators results for participative process

Communication and community engagement is not the subject of this task.

However taking into account that the "complex" aim of the toolbox is to provide a contribute to inform, educate or raise awareness, change behaviour and to support policy, in ***different context*** and in a ***flexible way***, it is considered appropriate to highlight that the tables and the graphs shall provide information that should be managed adequately because the "communities", to which the information may be destined, could be made up of different groups, that vary in their capacity for involvement and participation.

For this reason it is important how to frame messages and information for provide different pathways of awareness and we suggest to provide at the end of the process also a **clear and transparent** "take home message".

It is well known that messages that refer to closely related values usually have more appeal (Wilks et al., 2015). Taking the Italian action lab indicators results , as example, if the target community of the information are groups of individuals linked by a shared interest, as could be local farmers :

- tables and graphs could be used to explain that a contamination of some wells is evident and there is a contribute of the viticulture on local groundwater pollution and the time trend analysis also show a contamination decrease. The conclusion is that probably this is due to the waterprotect actions aimed to reduce the point source pollution and promote a better cooperation and information exchange between farmers.

  Nevertheless, this assumption requires an in-depth understanding and knowledge of the cultural and socio-economic conditions of the territory under analysis, to which information from the indicator must be associated. This is because of, despite is well recognised that public participation or community engagement have positive effect for good governance and social outcomes, research that has examined the effects of public engagement on environmental or ecological outcomes is poor (Dean AJ, et al., 2016).
- Information in table 1 on the pollutant detection are useful to rise awareness on the presence of a pollutant in the groundwater abut also to focus the attention on that ones there are over the legal limit and to discuss and better explore the cause of the pollution. This could allow farmers to understand why mitigation measures are proposed, the importance of their implementation and in particular for those that are mandatory by law confirming a bottom-up analysis approach.
- Information in the columns on the Hazard phrases in Table 2 should be used to raise awareness and convey information on the importance of *prevention* to limit *potential* pesticides operators health hazards and *potential* environmental hazards also if in this specific example monitoring target campaign are pesticides in groundwater and the H statement for Human Health or Aquatic Environment seems not necessary.

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5-Conclusion

The purpose of this work was to identify and select meaningful criteria associated to indicators to addressing the contribution of farming system on water management and the pressure of agriculture on water quality with the ultimate hope and goal:

- that the criteria will become the basis of a common approach,
- to estimate general trends in pesticide and fertiliser risk reduction in a flexible and dynamic perspective,
- to help to evaluate the effectiveness of measure or best management practice and,
- to help to find a community-friendly and easily understood language to engage and sensitize people that can easily follow what is being communicated.

Knowing that building up water management indicators for the agricultural system is a challenging task, the proposed methodology, although having some problems such different experts perspective, the complexity due to data availability and comparability within seven different case study, leads to a sharing of knowledge and thinking among the experts involved, and to a toolbox with suggestions for harmonised criteria.

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