D4.3 Synthesis report on the operational potential of ES/NC instruments

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Contents

KEY MESSAGES:

- STAKEHOLDER INVOLVEMENT at all stages: Involving the intended users of both the tool and its results throughout the tool development period helps ensure that the instrument aligns with their needs and abilities and promotes its uptake and success
- COMMUNICATION: Appropriate communication of the results to all relevant stakeholders is essential for uptake of the results
- APPLICATION: Key characteristics that influence the ability of the intended users to apply the tool (geographic location, cost, data requirements, time, complexity) should be taken into account;
- REUSE: It is preferred to redesign or adjust existing instruments instead of developing new instrument from a scratch
- MATCHING: a suite of connected tools and information of possible sequences of tools can help to meet pre-requirements (e.g. data needs) of selected instruments, and thus speed up use, information and decision making.
- FLEXIBLE PERSPECTIVES: bottom up and top down approaches for instrumetns are necessary to cater for different user groups and challenges to facilitate decision-making process.
- METADATA: Data about the tool (= metadata), such as geographic location, cost to obtain and implement the tool, data requirements, time requirements and technical knowledge needed) strongly influences the instrument selection and uptake. They should already be considered during the tool development phase in collaboration with the intended user to ensure the tool is appropriate.
- TOOL DEVELOPMENT PROCESS: Designing and following a post-development uptake strategy and user-friendly interface are crucial, non-neglectable part of the instrument development process.
- GOVERNANCE: For decision making in policy and implementation suitable governance mechanisms and incentives aids need to be designed as part of the stakeholder process to be successful

1. Introduction

Context

The concepts of Ecosystem Services (ES) and Natural Capital (NC) hold a powerful potential to support more sustainable development, improve ecosystem restoration and conservation, provide nature-based solutions and to improve the well-being of people. Harnessing this potential in support of policy goals ultimately depends on the concepts being operationalised (i.e. integrated and used) in ways that stimulate and support transitions from present practice to more sustainable ecosystem management; i.e. to support and facilitate decisions, actions and interventions that, directly and indirectly, influence how ecosystems are managed and which bundles of ecosystem services are preferred. The ultimate objective of operationalising the concepts is to deliver healthier ecosystems which provides a multitude of benefits that improves the well-being of people.

To fulfil this potential the NC/ES concepts have to be operationalised, i.e. assessments of status or value must be made and these results integrated into relevant policymaking and decision-making. The information system that supports ecosystem management decisions and actions can be considered to be an information chain. In simple form the chain begins with the collection of raw data: data are processed to deliver knowledge; knowledge is used to develop information relevant to support decision making; and decisions are translated into interventions and actions. Different tools and instruments (see box 1) are required at different points along the chain to accomplish the tasks of collecting appropriate data, developing useful knowledge, converting knowledge into information salient for decision making, and translating decisions into actions and interventions.

This means that the NC/ES concepts need to be integrated into tools and instruments that are used for different purposes at different points in the chain and in different arenas (science, policy, planning, business, etc.) and to support decision and actions at various levels from high-level and strategic to low-level and routine operations. There is therefore a wide range of relevant tools and instruments into which NC/ES concepts are being integrated.

Tools and instruments under the OPERAs Project

The OPERAs project has worked to integrate the NC/ES concepts into many generic tools and instruments used by ecosystem scientists and practitioners to develop, analyse and represent NC/ES data, knowledge and information, as well as into ecosystem specific modelling tools/suites. Work Package 4 (WP4), in particular, has focused on developing and enhancing new and existing

> **INSTRUMENT**: “A means of pursuing an aim” (Oxford Dictionaries).
> In OPERAs WP4 “instrument” was used as a term for a **framework, concept or approach**. E.g. Offsetting, PES (Payment for Ecosystem Services)
> **TOOL**: “A device or implement, […] , used to carry out a particular function; In computing: A piece of software that carries out a particular function, typically creating or modifying another program” (Oxford Dictionaries).
> In OPERAs WP4 “tool” was used as a term for concrete, **executible** or **software-based** means that can be used to support the implementation of instruments. E.g. ToSIA, TESSA

instruments. These can be separated according to their function into policy support, information,

decision-support and implementation. While instruments refer to documented approaches, concepts and frameworks, tools are more software based or models.

About this report

This report is the synthesis deliverable of WP4 and thus brings together the overarching message of experiences and results of the joint WP4 Instruments work. It is aimed at those developing ES and NC instruments, or those considering funding the development of such instruments, in order to ensure that lessons learned under the OPERAs project are taken into consideration in future tool instrument development.

The report considers four stages in the development and uptake of tools and instruments:

- Identification of the need for a tool/instrument
- Development of new tools/instruments
- Uptake and application of tools/instruments
- Uptake and integration of results into policy and decision-making

For each of these stages, the report will discuss work completed under the OPERAs project, and lessons learnt for others undertaking tool development or enhancement.

Lastly, four examples from the OPERAs project are provided as Factsheets at the end, which describes how the different exemplar has used and combined different tools to maximise the impact of their research and to ensure integration of ES into the decision-making arena. Short excerpts are included throughout the document to illustrate the key points.

2. Identification of the need for an instrument

A thorough inventory of the existing tools and instruments is crucial in order to understand where existing tools/instruments could meet a need, where improvements or enhancements are needed to existing tools/instruments or where new tools/instruments could be required Figure 1.

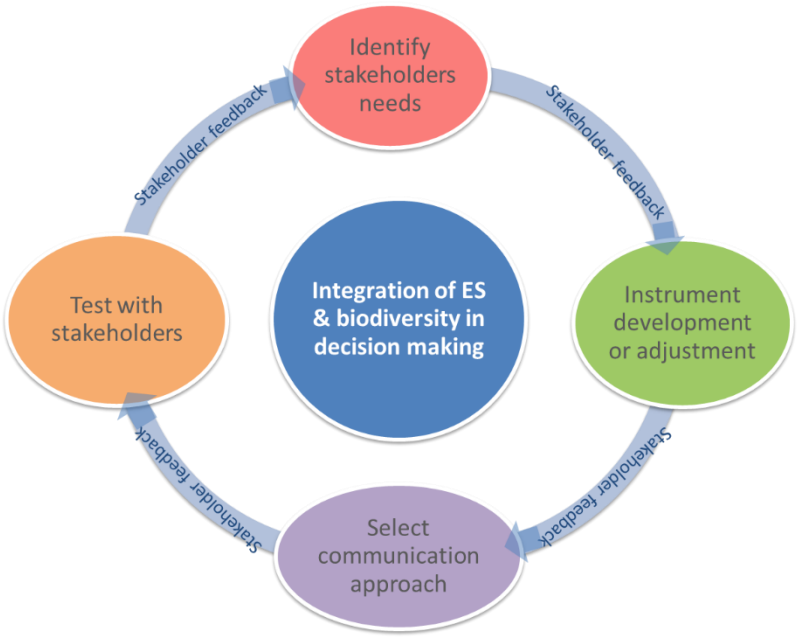
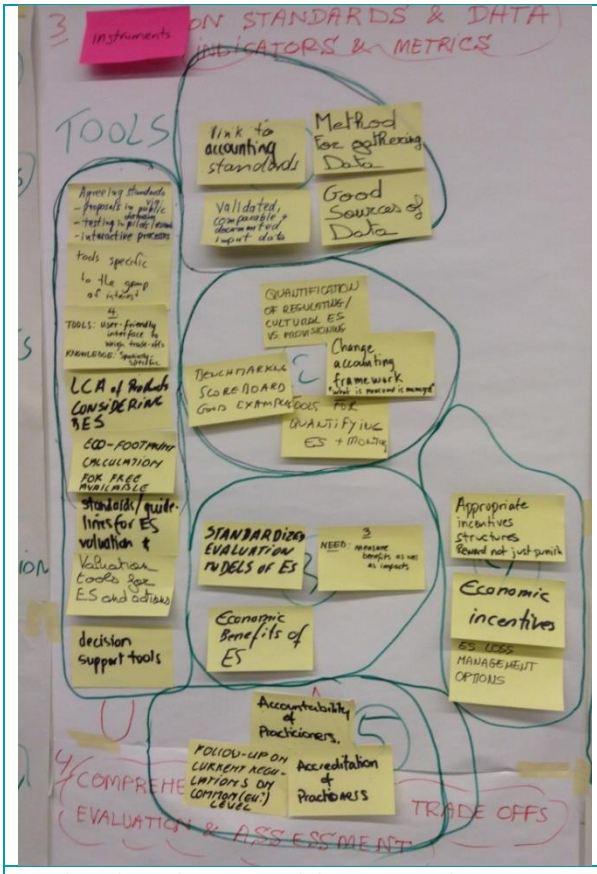


Figure 1: Stages during instrument development and points of stakeholder interaction

Under OPERAS this was done twice. The first iteration was during the proposal phase, when the tasks for WP4 and related instruments and partners where chosen. The choice back then catered for a certain range different types of instruments (policy, information, decision making, implementation), topics and sectors. This choice was not extensive nor meant to be, but rather as a basis for developing Oppla. The spread ensured that Oppla, together with the choice of instruments from OPERAS and OPENness projects is flexible and versatile enough to accommodate any further new instruments that were/are uploaded to oppla.

Secondly, after the start of the project, the selection of OPERAs' plans was validated through a blind selection in the first Userboard meeting in Brussels (Figure 2**Error! Reference source not found.**).



Userboard members mapped their user needs

OPERAs put those needs into a framework and cross-checked the needs against the plan

Figure 2: Matching and categorisation of user wishes as expressed during Userboard I and identified needs for ES tools and instruments OPERAs project

The stakeholder needs, as identified at Userboard I, matched the plans for OPERAs work in WP4, as identified in the OPERAs Description Of Work (DOW), and guided the further work of developing a framework to show the flow from data, to assessment tools, to instruments and measures and thus to influence policy. Further, stakeholder needs were specified in the Exemplar Study Designs (D2.1) which also influenced the instrument development within Work Package 4. This helped to understand and visualize the different types of tools and instruments, and how they support policy, which was key to understanding needs. It is important to note that the distinction is often not so clear cut, and instruments may act at multiple levels – a tool may include data collection, for example.

The Wine Exemplar demonstrates how many tools and instruments can be used concurrently or to support one another in one case. Indicators were used for both Life Cycle-based Assessment tool WeLCa to determine at what stage of wine production there is biggest ES impact in terms of biodiversity (i.e. at vineyard management stage), and for Sustainability Impact Assessment tool ToSIA to show the environmental, economic and social impacts of a chosen scenario (i.e. increase of sustainably produced wine – which can them be mapped). The outcomes of self assessment under WeLCa allows users (farmers, industry, retailers) identifying environmental hotspots and hence to take informed management decisions by selecting options for further improvements.

Equally, different instruments may be used together and feed into one another. In defining the need for a new instrument, it is important to understand how the flow from data to assessment will work – e.g. where will data come from? Are there specific assessment tools whose outputs will be used in a proposed instrument? How will results from a new assessment tool support instruments and measures?

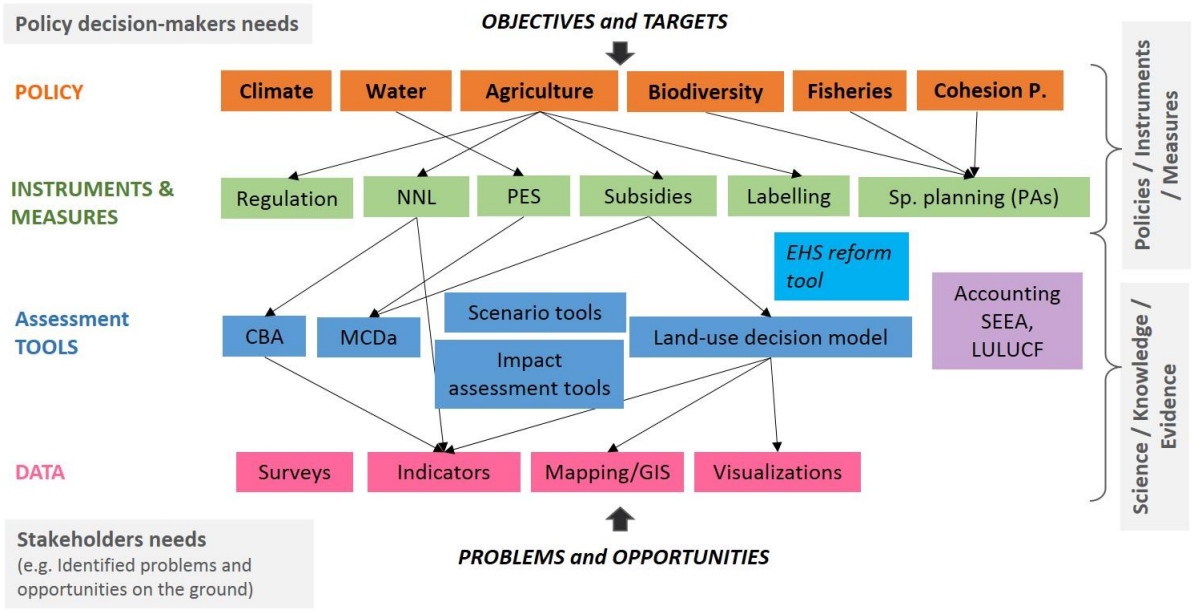


Figure 3: Diagram showing the multiple levels of the information system required to influence decision-making, with examples of how different levels/tools can be linked and combined.(NNL= No-Net-Loss, PES= Payment for Ecosystem Services, CBA=Cost Benefit Analysis, MCSa=Multi Criteria Decision Analysis).

The framework (Figure 3) visualizes the logical flow of instruments used in sequence, connecting them to the issue in question. It demonstrates the potential linkages between different types of instruments and the different levels through which data and knowledge feed into decision-making.

The flow through the diagram can start from either the top or the bottom level. If starting from the bottom of the diagram, stakeholders' needs should first be identified. In response to these, data is collected using data tools (e.g., LANDSCAPEization, Streamline), which may take various forms such as survey data or maps derived from remote sensing. The data collected can then be fed into assessment tools (e.g. Iodine (CBA), mDSS, BackES). Some tools can also be

Example from the project: The Wine Exemplar demonstrates how many instruments can be used concurrently or to support one another in one case. Indicators were used for both Life Cycle-based Assessment tool WeLCa to determine at what stage of wine production there is biggest ES impact in terms of biodiversity (i.e. at vineyard management stage), and for Sustainability Impact Assessment tool ToSIA to show the environmental, economic and social impacts of a chosen scenario (i.e. of Systembolaget buying a specified amount of sustainably produced wine – which can them be mapped). The outcomes of self assessment under WeLCa allows users (farmers, industry, retailers) identifying environmental hotspots and hence to take informed management decisions by selecting options for further improvements.

used both as data collection tools and assessment tools (e.g. TESSA). The results from these assessment tools can then inform the next level: instruments and measures tools (e.g. No Net Loss) that help directly ensure the incorporation of ES into policy and decision-making.

If starting from the top, the policy domain will determine the most suitable instrument(s) and measure(s) to help integrate the ES and NC concepts; in order to design these instruments, specific assessments will be needed which will themselves rely on data relating to specific issues.

Under OPERAs, a specific needs assessment was also carried out for the exemplars under the project to determine the tools and instruments for development or enhancement that would best fit with their needs (see Exemplar Study Designs (D2.1)). However, the timings of this user needs assessment was such that the tools had to be selected at the same time as the report on user needs was due, limiting the opportunity to fully take this comprehensive assessment into account when selecting tools for development or enhancement.

A key lesson learnt from the tool development process under OPERAs was the importance of ensuring that tools developed fill a known gap and have a clear policy aim, which has been identified in conjunction with the intended user. It is also important to consider whether a new tool is really necessary or whether an existing tool might meet the users' needs, if necessary with adaptation. The tool and instrument landscape is complex, and there are many available for use; however, understanding this landscape is challenging and often the reaction is to simply develop a new tool, rather than fully exploring the opportunities to make use of or adapt those that are already in existence. Instead, what is needed is a close collaboration with future users of the tool from the onset of the project, to ensure that the tool which is selected for use or which is developed meets the need. This will in turn ensure uptake of the tool ones project is finished.

3. Development of new tools and instruments

Under OPERAs, several tools and instruments were developed and enhanced, and the list in Oppla continues to grow. These included cost-benefit analysis, multi-criteria decision support, visualization, and participatory methods among others. The tools and instruments covered a range of ecosystem services, and had a range of technical and other (e.g. resource) requirements. Tools also ranged from those targeting very specific geographic locations, to those with the possibility to be applied anywhere, with varying amounts of work required for calibration or preparation.

Within the project, the experience of tool development highlighted the importance of involving the intended user from the start and throughout the process to provide feedback on the use and usability of the tool, and to define a number of key characteristics which would influence the ability of the intended user(s) and others to apply the tool.

Firstly, a tool's usability at any geographic location should be a key consideration when developing tools, and should be established in consultation with potential users and funders of the tool to facilitate the tool's uptake and potential impact. Those developed for specific locations will have more limited uptake and require greater investment and work to promote their uptake in other areas.

Secondly, another important characteristic that determines whether a tool will be used is the cost to obtain and implement it. Most of the tools developed or enhanced under OPERAs are freely available, although some resources may be required to actually implement them (e.g. engaging stakeholders or collecting data).

Example from the project: A No Net Loss tool was developed and tested in the French Alps exemplar, building on the scenario tool. Additional information was added such as available spatialised ecological data of the studied region and knowledge from biodiversity offset experts, ecologists and agronomists. This module may inform decision-makers on the capacity of a given area to support economic development and the in-kind offsetting of the resulting impacts, under several scenarios.

Data requirements for the tools was also an important characteristic. Tools that allow for data collection are important for operationalisation as they have the potential to be used in conjunction with other tools and instruments that require data. It is also important to consider what data users actually have or can reasonably collect and ideally ensure tools make use of this data, rather than requiring data that users might not otherwise have reason to collect.

The time required to use a tool is also key in determining its uptake; those that require less time, or that can be adapted to a user's available time, are more likely to be taken up – this should be taken into consideration during tool development, and for those more complex tools requiring longer to implement, where possible options for shortcuts should be identified.

The level of technical knowledge required to use a tool, together with the training resources available, also influence its use – therefore, tool developers should bear in mind the complexity of the tool relevant to the ability of its intended users during the development phase. Where needed, they should plan for the production of detailed training resources, such as guidance or video tutorials, which will help to 'hand hold' the user through complex aspects, and thus enable independent application of the tool. Equally, it is important to recognise that users may not have the time or resources to dedicate to extensive training, and thus a simpler tool that meets users' needs may be preferable and more likely to be taken up.

4. Uptake and application of new tools and instruments

The design of the OPERAs project was such that from the outset each of the 12 Exemplars under the project identified relevant tools and instruments that they could apply, with the aim of each developed or enhanced tool and instrument being trialed in at least two Exemplars. As such the project assisted tools in ensuring up take, and allowed tool developers to 'hand hold' users through the implementation of the tool. This close contact was extremely valuable in obtaining feedback on

the tool, but may also mean that the environment in which the tool was applied was more supported than would normally be the case, which should be taken into account. In some cases, the uptake of tools was limited by their selection prior to the aim of the Exemplar being clarified, or in others the aim of the Exemplar changed over the course of the project. This then led to delays in use of tools/instruments, or in the tools/instruments initially selected no longer being appropriate and alternative tools/instruments being selected.

Nonetheless, it became clear through the duration of the project that the most important factor in ensuring that a tool or instrument was selected for application was clarity of purpose, scope, requirements and outputs of the tool. Users needed to easily be able to fully grasp the aims and objectives of the tool or instrument to ensure that it aligned with their objectives. They needed to be completely clear as to what the tool could offer them, its limitations and its opportunities. It was also important that they understood exactly what inputs the tool needed – for example, what data, in what format. Finally, users had to be clear on exactly what the results or outputs from the tool or instrument would be, and how they could be used. A lack of clarity in these regards prevented some tools being selected for use by some or even all Exemplars, and emphasized the importance of involving the user in the tool development process.

Consequent and continuous stakeholder involvement is key to the successful application of many ecosystem services and natural capital tools and instruments, particularly given the personal nature of the values placed upon different services. As such, successful engagement of all relevant stakeholders (not just the intended users) throughout the application of the tool is key to ensuring they understand and support its results. This requires careful communication, to ensure that they understand the complex concepts and terms being discussed.

The five key characteristics identified in the previous section (geographic location, cost to obtain and implement the tool, data requirements, time requirements and technical knowledge needed) all strongly influence the uptake of the tool, and thus should be considered during the tool development phase in collaboration with the intended user to ensure the tool is appropriate. This highlights the important of involving the intended users and all other stakeholders throughout the tool development period to ensure that the tool aligns with their needs and abilities.

5. Uptake and integration of results into policy and decision-making

The OPERAs project runs from 2012 until 2017; such a timescale limits the conclusions that can be drawn in terms of uptake and integration of results from the tools and instruments into policy and decision-making, as the timescales on which policies and decisions are made can be far greater.

While a number of the tools and instruments saw policymakers and decision-makers engaged in their application, some tool users encountered challenges in getting the results used and taken up by the decision-makers. For some, the immediate policy relevance of the results for decision-makers were unclear (see Swiss Alps box). For others, the challenge was more in engaging decision-makers as stakeholders in the implementation of the tool itself. The general conclusions were that decision-

makers need to be engaged early on in the process, even in choosing the appropriate tool, in order that the correct questions are being asked and therefore that the results are appropriate and useful, both in terms of their scope and in terms of their scale and resolution.

One of the key challenges for ensuring the uptake of the results from these tools is the lack of awareness of and capacity to use the concepts of ecosystem services and natural capital among decision-makers and other stakeholders to allow them to understand the tool and its aims. It is therefore important to work to communicate the results clearly and using appropriate language (i.e. avoiding technical terms).

Some tools require long-term engagement from stakeholders, including decision makers, to ensure successful results and their uptake. Maintaining such engagement can be challenging, but tool developers under OPERAs have overcome this through continuity of researchers and personal interactions.

A very important lesson to support the uptake of results was that tool developers should provide guidance for users as to how to interpret the often-technical data and results from the tool or instrument in a policy-relevant way in order for it to feed into policymaking and decision-making processes. Continual stakeholder engagement throughout the application of the tool will also support this.

Example from the project: Although the Swiss Alps exemplar has not yet seen direct impact on policy programs and planning on the region, the project has however sensitized many relevant stakeholders and also the broader public which may help the uptake of ES in the local political arena in the longer term.

In the second alpine exemplar, results were shared regularly with stakeholders, who were involved from the start in defining the land-use change models and scenarios. This will help to understand the usefulness of using an ecosystem services approach to assessing scenarios and options for policy implementation, including forecasting urban development options that are compatible with 'no net loss' goals.

6. Conclusions and recommendations for future tool development

The experience in the context of OPERAs has shown that operationalising the concept of ecosystem services – via different tools and instruments described above – can increase the overall sustainability of policies and decision-making. However, in order for these opportunities to materialise an uptake of the concept by a range of policies underpinning different sectoral activities is required. Such sectoral policy integration is needed for two reasons: it minimises the damage to ecosystems and their services caused by sectoral activities and maximise the positive contribution of these activities to conservation. The integration of ecosystem services into sectoral policies can also contribute to achieving sectoral and other wider policy objectives in a more sustainable manner, increasing policy effectiveness and create potential win-win solutions between delivering different policy objectives.

The work carried out in the context of OPERAs WP4 has shown that the current and future progress with the mainstreaming of ecosystem services in sectoral policies varies across policy areas and

governance levels[123]. Without further efforts in sectoral integration, different policy sectors from EU to local level will continue to underperform as regards their contribution to achieving the targets for conserving biodiversity and ecosystem services. The findings from OPERAs research suggest that continued efforts are needed to assess further opportunities and needs for sectoral integration of ecosystem services into policy implementation, helping to pave way for further uptake and mainstreaming of concrete tools and instruments at different levels of governance[4].

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[3] Pantzar, M. and Kettunen, M. (2017) Integration of the Ecosystem Service concept into management and designation of EU Marine Protected Areas, draft manuscript

[4] Kettunen M, ten Brink P (2015) Towards a framework for assessing current level of and future opportunities for ES/NC integration at different levels of governance. Report for the EU FP7 OPERAs project, D3.3, Grant Agreement No 308393, January. Available at: http://operas-project.eu/sites/default/files/resources/d3-3towards-framework-assessing-es-nc-integration-different-levels-governance-final-draft-4-feb-2015.pdf

FACTSHEET 1: Information and visualization driven case with local authorities – Alpine exemplar

Research in the Swiss Alps exemplar was problem-driven as indicated in Figure 4. The Exemplar study region is a continental inner-Alpine mountain area affected not only by changes in precipitation patterns, but also by many socio-economic drivers of mountain land-use change. Traditional farming systems are in decline, while touristic activities and settlement development are continuously growing. Stakeholders, including regional planners, farmers, foresters and local politicians are increasingly worried about the loss of the identity in both the open landscape and their villages. To address these concerns we set up an inter-and transdisciplinary research design as presented in Figure 5 with the aim to derive policy and management strategies that sustain the provision of demanded ES against global and regional pressures.

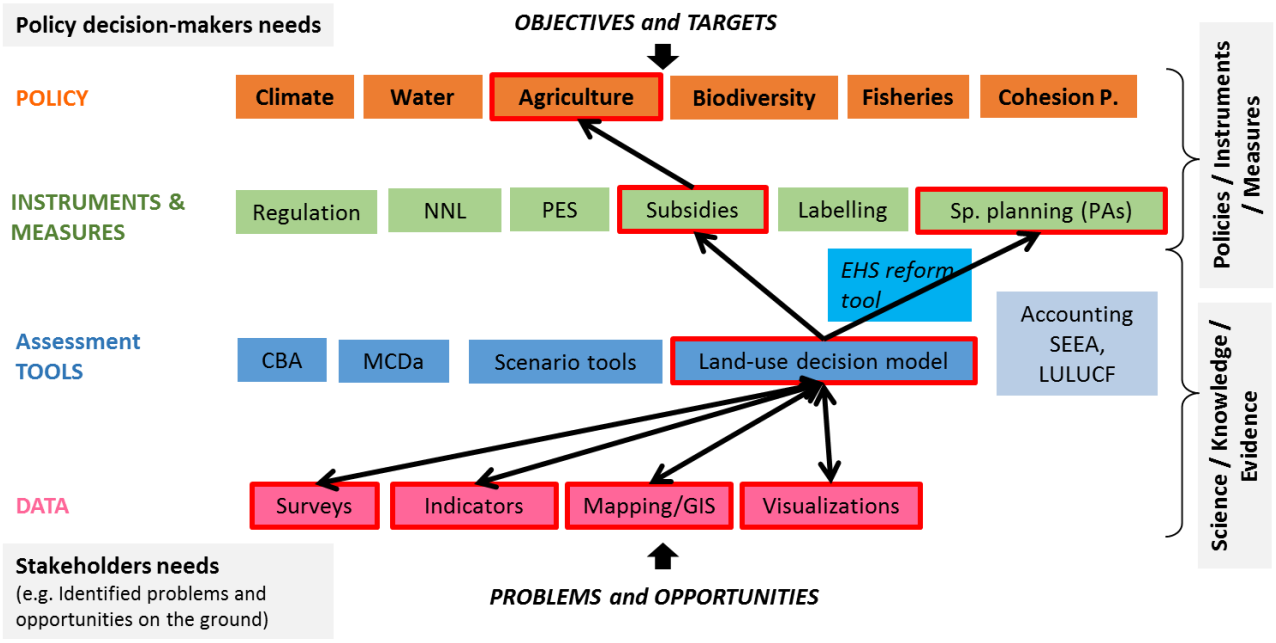


Figure 4: Problem-driven orientation (i.e. landuser decisions) of the research.

To launch the work in OPERAS, we held a first workshop, in which we addressed and framed experts' concerns and needs regarding ES in the region. In the workshop we also presented and discussed outcomes of past research activities in a forerunner project. Though critical towards scientific results, the experts were very interested in understanding the dynamics and capacities of the landscape and in learning more on socio-economic and political conditions that result in irreversible losses of ES in the longer term. They clearly emphasized the need to prioritize locally and regionally provided ES, especially cultural services, and to consider local demand and values in the assessment. In light of the growing pressure on agricultural land, the experts claimed for locally adapted and spatially explicit solutions and long-term policies that reconcile traditional agricultural

practices and multiple stakeholder interests. In order to provide decision-makers with sound and understandable information for developing and discussing such long-term oriented policy strategies, we started in parallel a demand analysis for gathering practices' requirements for ES information, representation and visualization options. An online survey has been distributed among the ES community and practitioners in spatial planning in Switzerland. Results from this survey helped set up the choice experiment and the collaborative decision platform which was used in the second workshop. Based on a selection of four target ES (landscape aesthetics, cultural heritage, biodiversity, natural hazard protection) and useful visualization forms we then set up a choice experiment among the local residents to assess future demand for ES. In a second step, we simulated various pathways of ES supply under different policy strategies and global change scenarios and evaluated for each model run, how well ES demand is satisfied at a mid-term planning horizon. Results from the backcasting exercise were then integrated into a collaborative decision-platform which was developed in parallel. In this format, the results were made available to policy-makers for discussing and negotiating concrete policy interventions that balance conflicting interests and maintain ecosystem services in the Exemplar.

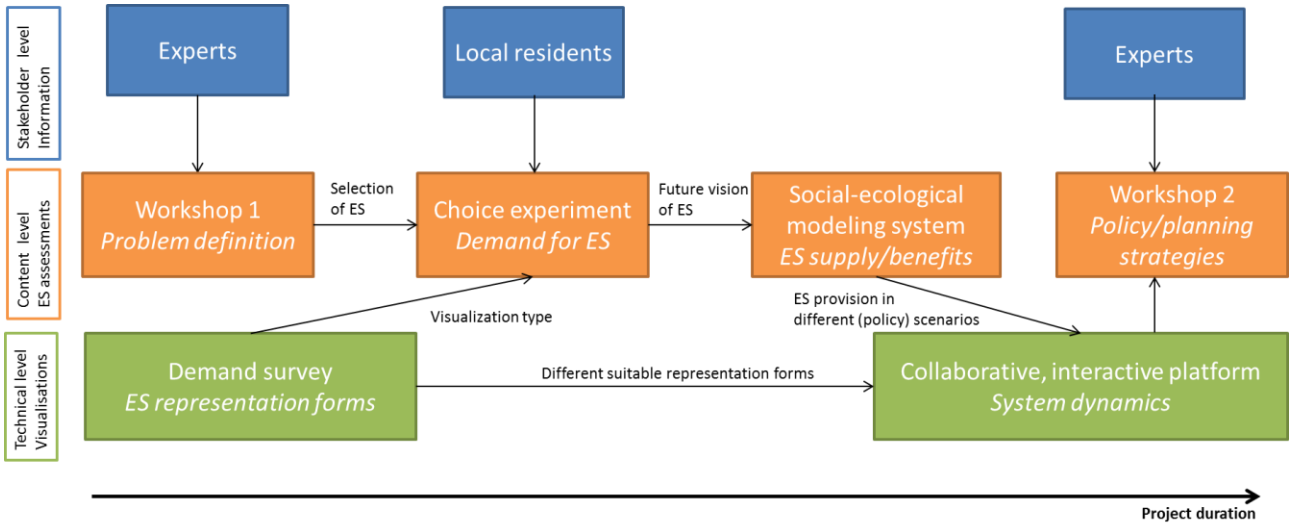


Figure 5: Research design in the Swiss Alps Exemplar.

The inter- and transdisciplinary research approach in the case study was successful in generating system-, target-, and transformation knowledge. Success factors in the beginning of the project were an iterative discussion about terminology and revision of interfaces of methods among scientists of different disciplines, the personal interaction with stakeholders and the continuity of the Exemplar. Especially the long-term involvement of several researchers in the region and with practitioners helped in engaging people and building trust. Regarding the involvement of stakeholders in the choice experiment, the study was socialized with the local population by an article in the local newspaper and by a local radio station interview with one scientist out of our team. Nine trained university students which grew up in the case study region contacted each chosen household personally. The students spoke the local dialect of the region which proved to be very helpful and trusty for the people, the response rate was 43% which is very high for this kind of experiment. Most challenging was the stakeholder interaction in the second workshop, as participants had to deal with both a novel visual interface and the results of the scientific analysis. Based on six policy pathways

stakeholders could interactively explore the effects of alternative planning strategies on ES supply. General feedback was positive, especially regarding the possibility to compare different currently discussed and regionally relevant policy options and the integration and representation of different sectors. However, participants suggested improved spatially explicit representation of local preferences and ES supply to support joint regional policy-making processes that account for specific characteristics and needs of involved communities. So far, there was no direct impact on policy programs and planning in the region. The project however sensitized many relevant stakeholders and also the broader public which may help the uptake of ES in the local political arena in the longer term. The results of our analysis could however also inform policy-making at the national level: we inferred which national agricultural and spatial planning reforms could contribute to better maintain mountain ES.

FACTSHEET 2: Scenario-based modelling of local land-use policy choices to achieve No Net Loss of wetland functions – an additional tool used in the French Alps exemplar

Offsetting is the last step of the mitigation hierarchy that must be followed by developers in the design and implementation of projects with impacts on biodiversity and ecosystems. In the context of the (delayed) EU No Net Loss initiative, and recent changes in French environmental regulations, the goal of mitigation is increasingly to achieve “no net loss” of biodiversity. Local governments are struggling to find ways to achieve this goal, which typically requires that developers offset any unavoidable impacts through on-the-ground conservation actions or ecological restoration. The design, location and timing of adequate offsets is a technical and organizational challenge that is driving innovation.

In the French Alps exemplar, land-use change was modelled, up to 2040, based on recent dynamics of urban expansion. We added offsetting of the impacts of urbanization on 170 ha of (mostly cultivated) wetlands to the model, to investigate the consequences of various types of offsetting, and in particular the effects of a recent shift to ecological equivalence focused on wetland functions, rather than on the loss of wetland area only. We worked at the scale of sub-watersheds, within the study landscape.

Simulations were based on spatially-explicit modelling and take into account existing planning recommendations to guide the location of offsets. Two mechanisms were tested for offset implementation: (a) case-by-case compensation where each developer compensates his or her impacts, resulting in many restored wetlands of various sizes located on available land, and (b) a centralized or aggregated approach where larger sets of adjacent parcels of land are used to compensate for several projects at once, generating larger wetland units. In addition, two different methods for sizing offsets were also compared: (i) an area based method whereby a 200% or 100% coefficient is applied to the impacted area to determine offset size, and (ii) a method where losses and gains of ecological functionality are calculated and offsets sized so as to ensure the generate enough gains to achieve no net loss of functionality. Wetland functionality was assessed using detailed information on agricultural practices (rotations) and expert opinion from agronomists and ecologists. This was possible thanks to the particularly high quality of the data and outputs from the French Alps exemplar, but the approach is applicable to a wide range of situations.

Mechanisms and methods were combined into four biodiversity offsetting scenarios. For each of the four biodiversity offsetting scenarios, 5000 simulations were undertaken and a sensitivity analysis of several methodological choices we made were carried out. Results are summarized below.

- Scenario 1: Case-by-case location of offsets sized to cover 200% of impacted area - The focus on area is not enough to recover losses of wetland function from development (-14% relative to the no

net loss objective). This scenario models the way offsets have been carried out until recent changes in French policies on wetlands (in 2009 and 2016) and our results illustrate one of the main failings these changes aim to address.

- Scenario 2: Case-by-case location of offsets sized to cover 200% of impacted area with at least 100% focused on restoration of most degraded parcels (i.e. the most intensively cultivated) - This scenario is the closest to existing official guidance and applicable regulations. It leads to a net gain of ecological functions (199% of the no net loss target). This shows that the current regulations for wetlands should lead to better results than the area-based approach that has dominated practical applications to date.

- Scenario 3: Case-by-case location of offsets sized to maintain wetland functions on at least 100% of the impacted area - This scenario results in lower net gains of functions (133% of the no net loss target), and a smaller area under offsets (163% of the impacted area) compared to scenario 2. This demonstrates that the no net loss objective can be met on a smaller area, and hence in a more economically efficient way.

- Scenario 4: Centralized or aggregated offsets sized to maintain wetland functions – This scenario achieves the desired objective (116% of the no net loss target) but needs more area (185% of the impacted area) than Scenarios 2 and 3. This is, in part, due to the fact that for some sub-watersheds, it has not been possible to select the parcels with the highest ecological restoration potential because it would have led to an overshoot in terms of wetland functions. Aggregated offsets are increasingly recommended, and used, worldwide as they typically ensure more long-lasting biodiversity gains from more ambitious and large-scale restoration actions. Moreover, they enable stronger governance of the offsets to be put in place, as they are easier to control and monitor by regulators. A recent law in France now allows such aggregate offsets to be put in place ahead of actual impacts, in a system akin to "habitat banks" that mainly exist in the USA, Australia and Germany.

Striking the right balance between case-by-case and aggregated function based biodiversity offsets should lead to improved outcomes for maintaining or restoring wetland functions within watersheds, so as to enable them to provide necessary ecosystem services.

While theoretical and based on cartographic data, this method allows to assess, at a global scale, the capacity of a territory to support economic development and the offsetting of its consequential impacts on the environment under several biodiversity offsetting scenarios. These results could be shared with the French Alps exemplar stakeholders who were involved in the definition of the land use change models and scenarios in order to add socio-economic conditions to the biodiversity offsetting scenarios. This method could also be used in other locations, provided that attention is paid to the quality of input information on land uses.

The method and the preliminary results were published5 in December 2016 in "Science, Eaux et Territoires", a journal which is mainly read by practitioners. Final results are being synthesized for submission to an academic journal.

[5] Vaissière, A.C., Bierry, A., Quétier, F. (2016) Mieux compenser les impacts sur les zones humides : modélisation de différentes approches dans la région de Grenoble. Sciences Eaux & Territoires 21 : 14–19. http://www.set-revue.fr/mieux-compenser-les-impacts-sur-les-zones-humides-modelisation-de-differentes-approches-dans-la

FACTSHEET 3: Implementation case – Barcelona costal management

Context is important for establishing how best to operationalise an ecosystems approach and what added values this approach can offer. A prototype tool for contextual analysis, CODIFIES, is being developed within the OPERAs project. CODIFIES was used in two OPERAs exemplars to explore how contextual analysis can help operationalise an ecosystems approach and contribute to its design, implementation, monitoring and governance. The two exemplars are: urban dunes (Barcelona) and seagrass meadows (Mallorca).

An exemplar was established at the start of the OPERAs project focused on the ecosystem services of dune ecosystems in the vicinity of Barcelona. The natural dune ecosystem has been degraded largely by anthropogenic disruption of the natural longshore drift sand transport processes caused by the expansion of the Port of Barcelona. Natural dune formation no longer takes place and attempts to construct artificial dunes have failed. The exemplar was therefore conceived initially as a Nature-Based Solution to test the possibility of creating hybrid dunes by replicating the generative processes of incipient (early-stage) dynamic dune formation and to explore ways of financing experiments and projects of hybrid dunes creation by selling dune ecosystem services, such as storm and flood protection.

Contextual analysis using CODIFIES involved exploring the present regime of management interventions, its basis and its cost-effectiveness. This led to the exemplar being re-framed and its scope broadened to cover wider issues of sand management along the full stretch of coast impacted by anthropogenic interference in natural sand dynamics. The reframed exemplar confirms warnings that current interventions are not solving the problem of beach and dune erosion and may actually be extending the problem westward from the main focus of current attention, El Prat de Llogrebat, to Ginesta.

The re-framed exemplar has made policy recommendations to widen the set of actors and stakeholders involved in beach (de facto coastal ecosystem) governance, change the current management goals and indicators, and experiment with Nature-Based interventions. It is proposed these are financed by cost savings made by down-scaling the current programme of artificial sand recycling and replenishment, which incurs high recurring annual costs, but is ineffective.

Historically, (pre-1970s) a natural, active dune ecosystem provided storm protection and contributed to an advancing coastline. Owing to anthropogenic interference since then, there has been no natural formation of active (dynamic) dunes. The dune and beach ecosystem in the vicinity of Barcelona is severely degraded and is no longer regenerating naturally. An advancing coastline (net sand accumulation) has become a receding coastline (net sand erosion) in many places.

This should be a source of growing concern as sea-level rise and expected increase in the frequency and severity of storms present increasing risks of storm and flood damage to high-value property and transport infrastructures along the coastline. However, there is poor awareness of the risk to ecosystem services that the degraded ecosystem status entails, even among the major beneficiaries of those services, such as property owners and beach users.

The problems of dune degradation and loss of capacity for natural dune regeneration are symptoms of a broader problem. This has at least three elements. One is anthropogenic interference in the natural sedimentation processes of the dynamic coastal environment. Another is the management response to these interferences which, rather than working with and helping restore natural processes, has focused on artificially recycling sand and artificially constructing the coastal features (dunes, beaches, lagoons) that natural processes would have produced. The third element concerns the governance of the issues. Currently, only a small number of actors and stakeholders are involved in decisions about sand management and these are not necessarily those with relevant expertise or interests in outcomes.

Anthropogenic disturbance began with the creation of a network of maritime footpaths to increase access to the littoral by locals. This led to some dunes being stabilised using artificial materials and by planting vegetation to fix and stabilise dunes. Much heavier use is now made of the beaches and dunes by locals for sunbathing during the summer months, altering sand moisture and sand exposure levels and preventing dune-forming winds from transporting sand across and up the beach and constructing incipient dynamic dunes. Longshore sediment supply was reduced by the development of Barcelona harbour, which involved constructing a 1.74 km dyke perpendicular to the coastline and relocating the mouth of the Llobregat estuary to the western side of the new port. These developments interfered with longshore drift, sediment replenishment and natural beach and dune building processes.

Artificial dunes have been constructed to compensate for the loss of natural dunes. Artificial beaches have also been created at El Prat de Llogrebat to compensate for beaches lost through the harbour development. An artificial lagoon was created alongside the realigned estuary. However, these artificial replicates are not products of natural forces and dynamic processes and they are not dynamically adaptive to the ever-changing conditions around them. They are static and rigid features vulnerable to sea and wind (and human) damage. This response therefore depends also on building defences to protect these artificial features, such as stone barriers that separate artificial beaches from the sea. This approach generates a vicious circle of interference. It also precludes that the artificial structures can provide the range of ecosystem services that the natural dune, beach, and lagoon ecosystems provided, such as storm protection. It also prevents interchange between the different elements, such as through channels between rain-fed lagoons and the sea, which would form naturally under natural conditions to create important brackish-water habitats and access to these.

The artificial coastal landscape also requires constant human intervention to maintain its structures. The main intervention has been to establish a continuous programme of sand replenishment in an attempt to compensate for reduced longshore drift. This involves dredging sand from the seabed in the vicinity of Ginesta and dumping it off El Prat de Logrebat. This incurs high levels of recurring expenditure (ca. 1 million € annually). However, this programme is not effective. Evidence-based analysis within the exemplar of long-term sediment, beach, and dune dynamics confirms that the replenishment program is not solving the problem of erosion in the area of Prad de Llogrebat and is changing the morphology of the beach in the area of Estany de la Roberta. The absence of recovery of the dredging ditches also increases the storm and flood risk the Port of Ginesta and the stability of its dyke.

The history of the current management regime shows that a narrow range of actors and stakeholders was involved in developing the present approach and that each has a specific role, responsibility and specialism. The current governance arrangement was established following an environmental impact assessment of the Port expansion and the re-alignment of the Llogrebat estuary. The Environmental Impact Declaration prescribed the creation of a Joint Committee of Monitoring and Environmental Control (CMSCA), with responsibilities to monitor the identified set of environmental issues. Members of the CMSCA are the Port Authority, the Coastal Administration of the Central Government, departments of the Catalan Government, and one Municipality (El Prat de Llogrebat), because this was the municipality most directly impacted by port expansion.

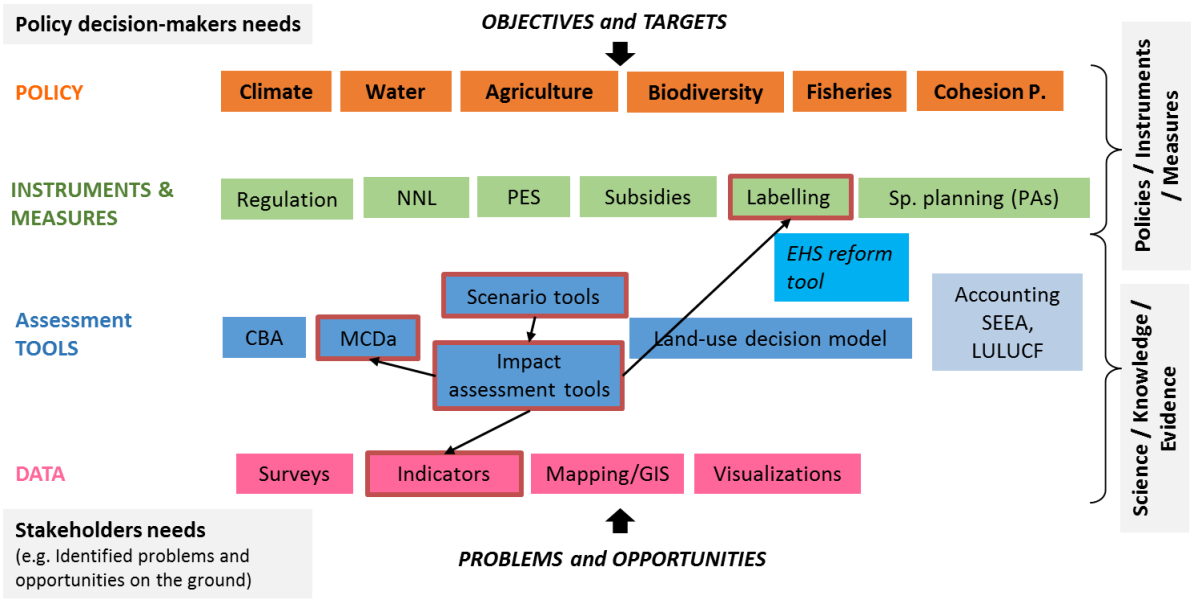
The port authority is responsible for financing sediment recycling as a response to interference in the natural sedimentation and longshore drift processes. However, the port authority is not a competent authority for coastal ecosystem management. Also the costs of the intervention programme are relatively small in the context of overall port operations. The responsibility of the post authority is limited to financing interventions and verifying these have taken place, but it does not extend to ensuring these are ecologically effective.

Our assessment of the current management regime highlights that problems have arisen by not looking holistically at the coastal ecosystem and instead taking a partial view, seeing the features of the landscape as separate from the dynamic natural forces that create them. Interventions have focused on addressing the most evident and immediate symptoms of interference and on locations where symptoms and impacts are manifest. Official monitoring of the coastal defence works does not cover the entire system, but wider evidence shows that interventions are not showing desired outcomes. However, those most affected by adverse impacts are not included in the CMSCA.

Our policy recommendations are therefore to: expand the group of actors and stakeholders involved in coastal defence governance; establish management criteria and indicators for the full stretch of impacted coastline; focus specifically on the emerged sand budget; reduce expenditure on the ineffective sand replenishment programme; divert some of the saved funds to finance experiments with Nature-Based solutions that work with natural processes to construct a hybrid and resilient beach ecosystem.

FACTSHEET 4: Wine Exemplar

With the advance of climate change, winegrowing conditions are changing. For example, new regions in more Northern latitudes are becoming more suitable for growing and producing wine. Meanwhile, traditional wine growing areas face challenges such as drought, which may require an adjustment of wine growing practices or wine grape varieties, or may even become unsuitable for growing wine. In the first case, new winegrowing regions can minimize trial-and-error by taking on lessons learnt from established wine areas, particularly with respect to maintaining soil quality, water quality, and biodiversity through sustainable, ecosystem-service- centered wine production. In the second case, ecosystem services play an even bigger role, such as maintenance and provision services (water availability and soil erosion, resistance to calamities pests and diseases thanks to due to biodiversity), in order to uphold cultural ecosystem services such as cultural traditional heritage values and pride in local wine and wine related food culture.



The wine exemplar within OPERAs seeks to understand how different actors in the wine value chain (producers, retailers, consumers) influence wine production and hence the ecosystem services provided by vineyard ecosystems. Three separate tools were upgraded and developed within the wine exemplar to comprehendanalyze this relationship and to be in support of management decisions or technological applications for achieving sustainability of entire value chain: WeLCa and ToSIA. A third tool, the ecolabel assessment tool, was developed to help producers and consumers to determine the trustworthiness and suitability of specific ecolabels.

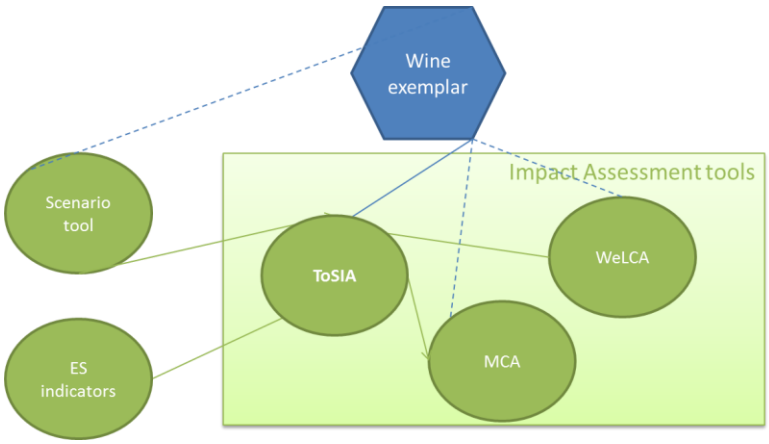
The first tool, WeLCa is a life cycle thinking-based tool designed to determine the biggest impact on biodiversity, closely related to the functioning of ecosystems and provision of services with respect to vineyards management. The tool comprises of two phases, providing quantitative and qualitative assessments respectively and addressing the issue of data limitations. While Phase I is targeted novice users to enable operationalization of the concept of ecosystem services and the importance of biodiversity, Phase II is targeted at advanced users and provides detailed assessment on the

impact of wine production on biodiversity during all production stages - at the vineyard, at the winery, as well as due to transportation, split by source of impact. The application of the WeLCA contributes to the testing of the most recent developments in the LCA community with respect to impact assessment on biodiversity.

The second tool, ToSIA is a Sustainability Impact Assessment tool designed to show the environmental, economic and social impacts of a chosen scenario. These scenarios were presented visually and step-wise in the Scenario Toolbox. Scenarios are expressions of "what would happen if", and – as the indicators – reflect considerations of stakeholder interest, reflecting changes in production systems like impacts of changing to organic or even more extensive sustainable wine production.

As a third and separate, but very enthusiastically greeted tool, an Ecolabel Assessment Tool is being developed that assesses the trustworthiness and suitability of any given ecolabel based on a rating scale. The scoring of an ecolabel's rating can offer insight to producers, retailers and consumers on what a specific ecolabel contains. This can help consumers to make an informed choice between products, based on their environmental and social performance.

Various types of stakeholders were approached to participate in the process of tools development and to provide insights on comprehensiveness, potential applicability and future improvements. These ranged from wine growers in England, as representatives of new wine growing regions, to Portuguese wine growers, as representatives of areas with a long cultural tradition. Further engagement encompassed the Portuguese wine association as well as Swedish retailers (Systembolaget) and importers. As of the time of this report, work in the wine exemplar with Portuguese and Swedish stakeholders is still ongoing (producers from England showed hesitant interest in cooperation), so only plans and work in progress, rather than results, can be presented. Firstly, surveys and interviews, to determine the most important aspects for stakeholders were executed and fed into defining vineyard ecosystem services and the most relevant indicators for measuring those. Stakeholders were interested in innovative low-environmental impact technology changes in vineyards and wineries; in considering the biodiversity - aspect, which currently has not been elaborated within the most commonly used life cycled-based tools, as well as in the (eco)labelling, marketing and sales perspectives. Intangible aspects like cultural importance and systemic impacts on taste and quality were among the most interesting requests, as well as the most challenging in expression as indicators.



Both ToSIA and WeLCa are designed as decision support tools and are data-driven, which can be considered a constraint for their application. For users, pure numbers can be difficult to interpret, while their general preferences are more clear. For ToSIA, MCA (Multi-Criteria Analysis) is additionally used to translate stakeholder preferences into preferred choices on quantified indicators, as well as for determining which scenario is preferred by a particular stakeholder.

Among the benefits recognized by the stakeholders, consulted on the instrument development, were that sales in the wine sector can profit by, for example, communicating to the consumers the importance of sustainable wine production and the benefits of good management practices for preserving ecosystems, and for reducing risks for the environment. Importers can also benefit by gaining information on how producers and suppliers are performing in terms of sustainable wine production. Increased transparency can account for building long-term relationships, which would can positively affect the market and as a whole increase recognition in the sector.

In the future, all of this information could be combined to develop a label or marketing campaign focused on the positive impacts of particular management practices or production systems. This in turn could drive both increased sales of sustainable wine and improvements in vineyards practices.

Effective environmental communication to different stakeholders focusing mainly on consumers and retailers is further explored in detail and presented in a separate factsheet on labels and communication (upcoming at Oppla).