

SOILGUARD

Sustainable soil management to unleash soil biodiversity potential and increase environmental, economic and social well-being

Grant Agreement no. 101000371

D6.1 Soil Biodiversity assessment as an NBS

WP	WP6 Conservation of soil biodiversity			
Author(s)	Alberto Martín Sánchez (UICN)			
Contributor(s)	Sauli Valkonen (LUKE), Tomas Van de Sande (INAGRO), Helle Hestbjerg (DTI), Merek Kesser (DTI), Zoltan Toth (MATE), Kerry Ryan (TEAGASC), Fiona Brennan (TEAGASC), Luis Daniel Olivares Martinez (UMH), Ina Alsina (LLU), Agrita Švarta (LLU), María Paula Barral (INTA), Rochana Tangkoonboribun (TISTR), Rattana Ngamvisitsil (TISTR), Santiago Soliveres (UA), Daniel Johnson (IOW)			
Reviewer(s)	Darío Pollicino (UICN), Catherine Numa (IUCN)			
Deliverable nature	Report			
Dissemination level (Confidentiality)	Public (PU)			
Estimated indicated person-months	3			
Date of delivery	Contractual	31-01-2023	Actual	31-08-2024
Version	1.4			
Total number of pages	72			
Keywords	Soil biodiversity, Sustainable Soil Management, Nature-based Solutions			

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

Document History

Issue Date	Version	Action
22/01/2023	V0.1	Initial version
29/01/2023	V1.2	Reviewed version
31/01/2023	V1.3	Final Version for Submission
31/08/2024	V1.4	Final Version for Submission after PR2 review
21/02/2025	V1.5	Disclaimer updated

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

Table of Content

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

List of Figures

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

List of Tables

List of Abbreviations

AR: Argentina

BE: Belgium

DK: Denmark

FI: Finland

HU: Hungary

IE: Ireland

LV: Latvia

ES: Spain

NbS: Nature-based Solutions

NCP: Nature Contributions to People

RTF: Rotational Forestry

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

CCF: Continuous Cover Forestry

SOM: Soil Organic Material

SSM: Sustainable Soil Management

TOC: Total Organic Carbon

SBWF: Soil Biodiversity and Wellbeing Framework

SENASA: National Agrifood Health and Quality Service in Argentina

DISTDYN: Forest management inspired by natural disturbance dynamics project

R&D: Research & Development

Disclaimer

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

Summary

This deliverable provides an assessment of on-the-ground Sustainable Soil Management (SSM) practices monitored during the project, following the IUCN Global Standard for Nature-based Solutions. To accomplish this, specific SSM practices in place across different regions were evaluated using an assessment tool specifically designed for this purpose. The development of the assessment tool considered two key components: 1) The Self-Assessment Tool for IUCN Global Standard for Nature Based Solutions (NbS), to define the overall assessment structure and methodology, and 2) the Soil Biodiversity and Wellbeing Framework (SBWF) as the specific conceptual foundation outlined in D1.3. This tool has played a crucial role in facilitating the evaluation of SSM practices and identifying barriers, and recommendations for better integration of these practices and interventions within the NbS framework.

The preliminary findings from D3.2 were incorporated as supporting evidence to justify the alignment of SSM with the assessed criteria. The results and insights derived from this assessment will prove valuable for upcoming WP6 outcomes.

1. Introduction

D6.1 Soil Biodiversity assessment is one of the main results of the task *6.1. Develop recommendations and raise awareness among the conservation organizations*, and includes the evaluation of the SSM practices in the regions of the SOILGUARD project through the criteria and indicators of the IUCN Global Standard for Nature-based Solutions (IUCN, 2020a). This process was executed applying an assessment tool that was developed to identify barriers and recommendations to better integrate SSM interventions within the NbS framework.

The document starts by providing a description of the context in which the work was developed, including an introduction to the SBWF (Chapter 3) and to the NbS and the IUCN Global Standard for NbS (Chapter 4). The general remarks of the assessment are described in Chapter 5, which includes the methodology of the overall process, the description of the assessment tool, as well as specific findings regarding the assessment. Chapter 6 includes the conclusions of the analysis and the rating for each one of the NbS categories analysed. Results of the assessment process for each region are included in Chapter 7. Specific attention was dedicated to considering economic values in SSM practices and to the links between SSM practices, soil biodiversity and soil-mediated ES, along with their simultaneous provision through soil multifunctionality. The insights gained from this assessment will be utilized to provide recommendations for a more effective integration of these interventions within the NbS framework, as outlined in *D6.2 Guidelines for implementing interventions where soil biodiversity functions as an NbS.* Figure 1 illustrates the main activities carried out for conducting the assessment and designing the management guidelines.

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

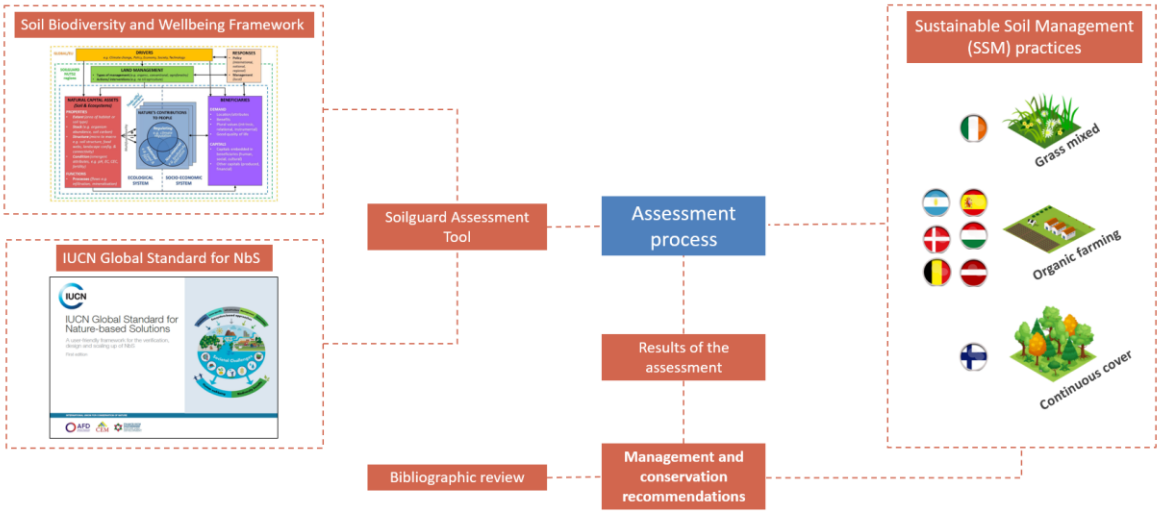


Figure 1. Diagram of the main activities carried out in T6.1 Develop recommendations and raise awareness among the conservation organizations

The objectives of assessing the case-specific SSM in SOILGUARD are to:

- Assess the performance of SSM using the criteria and indicators outlined in the IUCN Global Standard for NbS.
- Identify knowledge gaps and aspects of practice that warrant further investigation and exploration to enhance NbS interventions and their implementation processes.
- Mobilize and capitalize on locally existing knowledge to provide relevant insights for designing SSM practices.
- Extract lessons and insights to enhance the usability of the IUCN Global Standard for NbS.

2. Soil biodiversity and wellbeing framework

As it is described in D1.3, the SBWF (**Figure 2**) is a conceptual structure that identifies, define and describe the elements, processes, attributes and links related with soil management, soil biodiversity, soil multifunctionality, nature's contributions to people (NCP), and wellbeing.

The SBWF considers soil biodiversity and its capacity to deliver Nature Contributions to People (NCP) and wellbeing across socio-ecological systems. Within the SBWF, the natural capital assets cover the attributes (properties and functions) of soils and ecosystems essential for the delivery of NCPs. The SBWF highlights the central role of natural capital assets, illustrating their contribution in providing a wide range of soil functions and soil-based NCPs. NCPs encompasses material NCPs, such as food and fibre, regulating NCPs like climate regulation or soil erosion prevention, and non-material NCPs, such as biodiversity education or tourism. The delivery of NCPs generates benefits, such as nutrition from food or access to clean water facilitated by a water regulation service, subsequently translate into enhanced wellbeing of communities. Every element within the socio-ecological system may be influenced by external drivers, defined as external to the local socio-ecological system that can be present at European and global scales, such as climate change or land degradation. Land Management,

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

which is a part of the socio-ecological system directly influences natural capital assets by altering ecosystem properties and functions and affects beneficiaries by shaping the capitals employed to release NCP. Finally, the responses add a temporal dimension to the framework since specific outcomes may trigger changes in management or policy at different scales or levels to safeguard or enhance natural capital assets, adjust other capital inputs, or shape beneficiary demand for NCPs

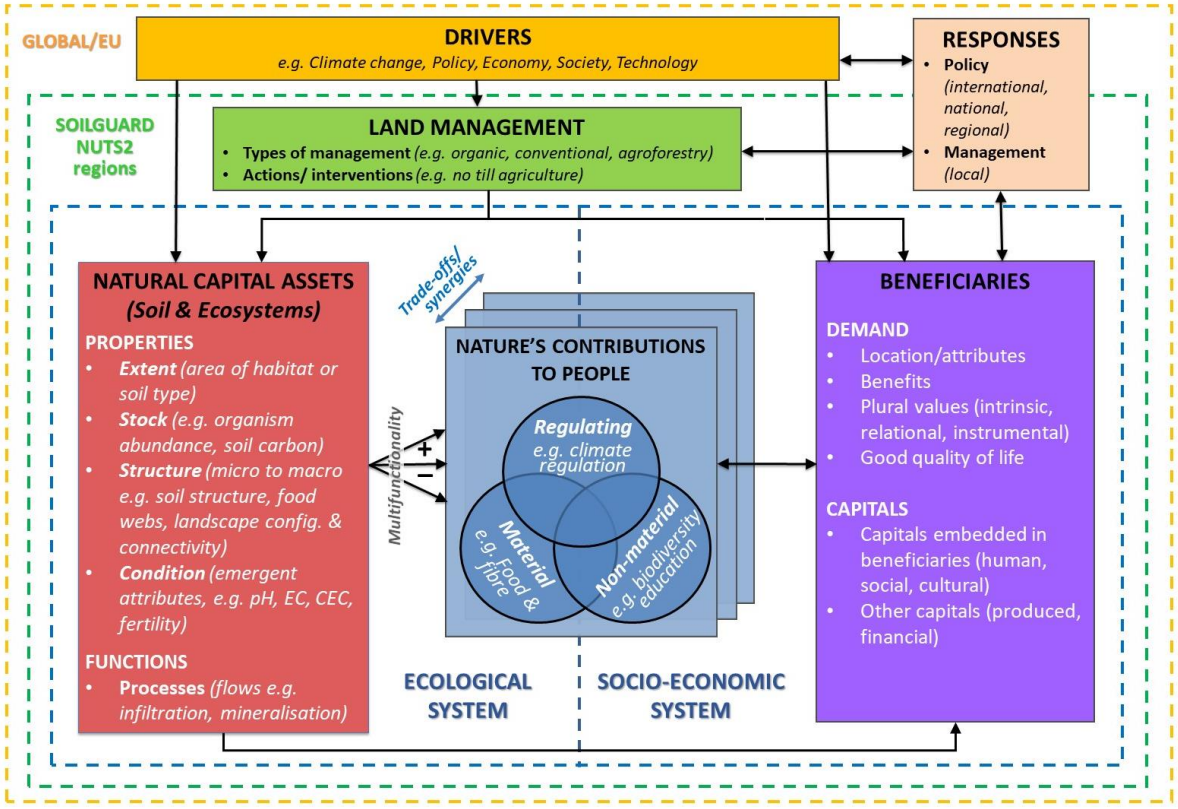


Figure 2.The Soil Biodiversity and Wellbeing Framework. Source: D1.3

3. Nature-based Solutions and the IUCN Global Standard for NbS

Nature Based Solutions (NbS) is an umbrella concept that covers a range of different interventions that have emerged from a variety of fields. However, they all share the objective of enhancing the beneficial features and processes of ecosystems to address societal challenges, such as food security, natural disasters, or climate change.

The term NbS has been defined and used in several different ways. For example, the IUCN, defines NbS as actions to protect, sustainably manage and restore natural or modified ecosystems, which address societal challenges effectively and adaptively, while simultaneously providing human well-being and biodiversity benefits (IUCN, 2020a).

The NbS concept has gained significant traction and was embraced, expanded, and supported by the European Commission. It has become increasingly common in literature on approaches for enhancing resilience to the effects of climate change (Cohen-Shacham et al., 2019; IUCN, 2020a). In recent years,

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

NbS has been integrated into policy, funding priorities, scientific literature, plans, and strategies, and has been applied and implemented by numerous institutions. The European Commission developed a Research and Innovation agenda on NbS in its Seventh Framework Program (FP7), included NbS in its Horizon 2020 Programme (Maes & Jacobs, 2015) and is addressing NbS in many of its Green Deal and Horizon Europe calls (European Commission, 2015, 2017). Though this, it has funded various projects to enhance the evidence base for NbS and develop multiple large-scale pilots and demonstration cases.

NbS are prominently featured in the European Green Deal and recent key European policy initiatives, such as the EU Biodiversity Strategy for 2030 (European Commission, 2020) and the new EU Strategy on Adaptation to Climate Change. NbS are also expected to play a crucial role in the implementation of the new EU Forest Strategy, as well as the EU Soil Strategy and European Zero Pollution Action Plan for air, water, and soil. Moreover, the implementation of NbS is considered a key factor for the successful deployment of other major European policies and strategies such as the Floods Directive, the Groundwater Directive, the Urban Waste-Water Treatment Directive, the Water Framework Directive, the Marine Strategy Framework Directive, and the Air Quality Directive.

With the increasing recognition of NbS, came a real demand to develop and provide useful tools and guidelines, such as the IUCN NbS Standard, to clarify the NbS concept and promote its implementation (IUCN, 2020b).

As NbS gains traction in policy and is adopted by multiple stakeholders and is used in a wide range of initiatives, there is an increasing need for greater clarity and precision regarding what the concept entails and what is required for its successful implementation. In this context, IUCN has facilitated the co-design of an NbS standard by combining knowledge, skills, and experiences from a wide range of stakeholders (IUCN, 2020b).

The IUCN Global Standard for Nature-based Solutions, therefore, ensures that there is a shared understanding and interpretation of the NbS concept, and facilitates the exchange of knowledge to enhance and improve applications (IUCN, 2020a). Furthermore, the IUCN Standard offers a specific and systematic framework to support the implementation of specific actions on the ground, accelerate policy development, and assess the design and execution of interventions through a process that promotes accountability (IUCN, 2020b). It also functions as a tool for developing a consistent approach to designing and validating concrete actions, avoiding a rigid framing with fixed, definitive thresholds for what NbS should achieve. The use of the IUCN Standard facilitates the identification of best practices to address environmental and social challenges, linking interventions to research narratives and relevant existing tools, approaches, and methods (IUCN, 2020a, 2020b).

The societal challenges currently considered in the IUCN NbS Standard are (1) climate change adaptation and mitigation, (2) disaster risk reduction, (3) ecosystem degradation and biodiversity loss, (4) food security, (5) human health, (6) social and economic development, and (7) water security. As NbS continue to evolve, there may be other specific challenges addressed within this scope and the development of NbS oriented to promote soil health could help to link the IUCN Standard with soil-related actions, and potentially, identify societal challenges not yet addressed. SOILGUARD is specifically focused on climate change, food security and social and economic development. Land degradation may be an additional challenge considered in SOILGUARD.

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

The IUCN Standard consists of eight criteria (**Figure 3**), each with a set of indicators, built on the NbS principles as well as feedback from a participatory process. These support users in two ways: 1) assessing the extent to which a proposed solution qualifies as an NbS, using a scale of strong, adequate, partial, or insufficient, and identifying what actions can be taken to further strengthen the intervention's robustness, and 2) facilitating the design of a solution that adheres to the criteria and indicators while building in adaptive management mechanisms to maintain the solution's impact (IUCN, 2020b).

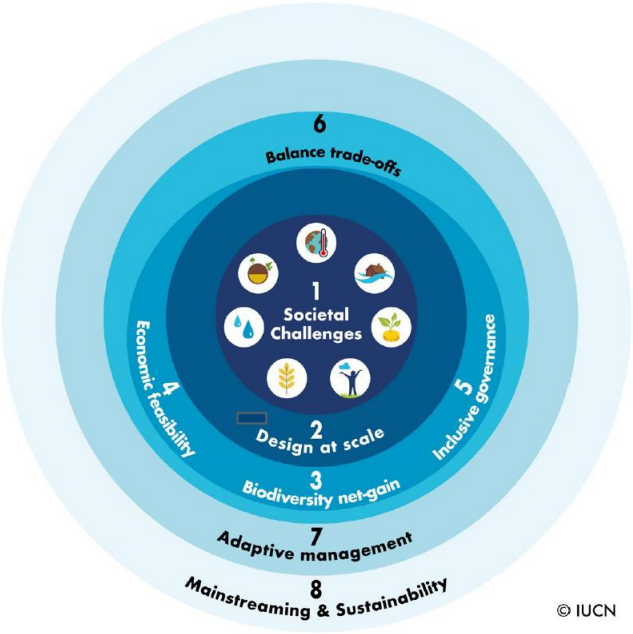


Figure 3. The eight Criteria that make up the IUCN Global Standard for NbS are all interconnected. Source: (IUCN, 2020b)

- Societal challenges: Criterion 1 emphasizes the importance of clearly identifying the societal challenge that the NbS will address to ensure deliberate and purposeful design aimed at meeting human well-being needs.
- Design at scale: Criterion 2 guides the design of an NbS by considering scale. While intervention activities can be focused at the site scale, the robustness, applicability, and responsiveness of the solution should consider the interactions that occur across different social and ecological scales.
- Biodiversity net-gain, economic feasibility and inclusive governance: Criteria 3, 4 and 5 outline processes that can enhance the chances of positive outcomes for biodiversity, society and the economy. However, to achieve these three Criteria, trade-offs need to be determined and made, which are directly addressed in Criterion 6.
- Balance trade-offs: Criterion 6 addresses the practicalities of navigating and balancing the trade-offs inherent in most natural resource management decision-making processes, including balancing immediate, short-term, and long-term outcomes. It emphasizes the importance of ensuring that trade-off decisions are made with equity, full transparency, disclosure, and consensus among all stakeholders impacted by the decisions.

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

- Adaptive management: Criterion 7 promotes an adaptive management approach, where learning and action complement each other to evolve and improve the NbS solution. This approach enables NbS to address uncertainties and respond to unintended, unforeseen, and undesirable consequences of the intervention.
- Mainstreaming &sustainability: Criterion 8 focuses on processes for mainstreaming NbS across spatial and temporal scales, to ensure that actions and impacts are sustained beyond stand-alone projects, sharing lessons to inform other solutions, and embedding the concept and actions into policy or regulatory frameworks. This includes linking NbS to national targets or international commitments.

Each of the criteria is divided in several indicators that may serve as a tool to enable users to evaluate the degree of alignment of their intervention with those eight criteria and determine whether it adheres to the IUCN Standard for NbS (IUCN, 2020b).

3.1. Assessment SSM practices

Within T6.1, the specific SSM practices that were in place in the different regions were reviewed using the UICN Global Standard for Nature based solutions and evaluated using an assessment tool (described in Appendix A). This assessment tool (detailed in Appendix A) has also been used to identify barriers and recommendations for better integration of these practices and interventions within the NbS framework.

This tool was developed considering 1) the Self-Assessment Tool for IUCN Global Standard for NbS to define the general assessment structure and the methodology and 2) the SBWF as the specific conceptual foundation. Consequently, the assessment followed all the aspects covered by the 8 criteria and 28 indicators described in the standard, but specifically focused on the elements, processes, attributes and connections detailed in the SBWF concerning soil management, soil biodiversity, soil multifunctionality, nature's contributions to people, and wellbeing.

Considering that the conceptual, abstract and strategic nature of the standard may be one of the main barriers to its use (IUCN, 2021), the objective of this process was to develop a more accessible, condensed, clear and practical tool that facilitates the necessity for specific and practical soil management guidance. Further, taking into account the potential benefit of a more operational approach for NbS (IUCN, 2021; IUCN, 2020b) this exercise may be a specific example of operationalisation of the NbS framework for soil biodiversity and SSM using the SBWF. The Soilguard assessment tool, can support users for: verifying and designing interventions and SSM practices, align SMM practices within NbS framework and can be used also in the regional and local implementation of different policies.

To this end, 14 assessment criteria were defined based on: 1) the criteria and indicators defined in the standard and 2) the relationships between SBWF elements. In this sense, all the criteria defined refer to the relationship between two or more SBWF elements so that the assessment process itself facilitates its understanding. On the other hand, some general concepts of the standard were replaced or adapted to the more specific SBWF concepts. Finally, some indicators were integrated into the various criteria of the assessment tool created. The first version of the assessment tool was presented to the Soilguard partners (LEITAT, LUKE, INAGRO, DTI, MATE, TEAGASC, UMH, LLU, INTA), and the feedback received was used to improve both the tool and the evaluation process itself,

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

strengthening the link between the tool and the SBWF. To develop de assessment the level of match of each SSM interventions against the 14 criteria has been estimated. The 14 criteria are:

1. SSM practices respond to the current state of ecosystems and soil biodiversity.
2. SSM practices recognize and respond to the interactions between the economy, society, and ecosystems, integrating complementary interventions.
3. Risks and trade-offs are identified, managed, and used to inform corrective actions and safeguards.
4. SSM must address societal challenges that are identified, thoroughly understood, and well-documented.
5. SSM practices have a positive impact on soil biodiversity and ecosystem integrity, with impacts periodically assessed.
6. SSM practices have a positive impact on human well-being, with impacts periodically assessed.
7. Stakeholders and beneficiaries are identified, and governance processes are participatory, inclusive, transparent, and empowering.
8. The rights, usage, and access to land and resources, along with the responsibilities of different stakeholders, are acknowledged and respected.
9. SSM practices are economically viable.
10. Lessons learned are documented and shared.
11. SSM practices are managed adaptively, based on iterative learning.
12. A monitoring and evaluation plan is implemented to assess unintended adverse consequences on nature and review established safeguards.
13. Relevant policies, regulatory frameworks, and national and global targets are identified and considered in the design of SSM practices.
14. SSM practices inform and enhance facilitating policy and regulatory frameworks and contribute to national and global targets.

Once the final version of the tool was completed, it was shared with the partners to gather information from each regional SSM practice and to apply the tool for executing the assessment. Specific bilateral meetings between IUCN and each partner (LUKE, INAGRO, DTI, MATE, TEAGASC, UMH, LLU, INTA, TISTR), were held to facilitate and support the evaluation process.

For each criterion, a score was assigned, depending on whether the intervention addresses the criteria to a strong, adequate, partial or insufficient extent (Table 1). To define the score the current status of the SSM practice in the region's sites regarding the issue assessed by each criterion was compared with the score description included in Appendix A. Thus, the score was assigned based on which was the description that was most closely aligned with the management system in each region. In cases where the information from the management system found was insufficient, the rating for that criterion was marked as N/A. A brief explanation describing the reasoning behind the rating chosen for each indicator is included in Chapter 8. Barriers to achieving the criteria and recommendations to better integrate those practices within the criteria were also identified. A traffic light system linked with the score for each criterion allowed to identify areas of improvement. A comprehensive depiction of the assessment tool and the criteria taken into account is provided in Appendix A.

Table 1. Scores given for each of the indicators in the analysis. Source: original work based on IUCN, (2020b)

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

How well has the criteria been meet according to the documentation?	Score
Strong	3
Adequate	2
Partial	1
Insufficient	0
Insufficient evidence	N/A

It is important to note that the practices monitored during the project were already in place prior to its commencement. Therefore, the criteria closely related to actions taken during the SSM practice design (1, 2, and 13) have been evaluated ex-post, considering the initial information used in the design and the current status of each aspect.

The assessment was developed considering the information of all the sites under SSM of each region, to ensure that a representative sample is considered and also, taking into account that even if the execution of the solution is at a site level or smaller scale, the larger scale level considerations can greatly inform the robustness and durability of the solution (IUCN, 2020b). In this regard, in order to align SSM with NbS criteria, intervention design should take into account the interactions that occur across different social and ecological scales within a landscape. At each phase of the development and execution of the management practices, the larger landscape should be considered because ecosystems are affected by and have effects on the larger land and seascape in which they are embedded and because some ecosystem goods and services are generated at the landscape scale (IUCN, 2020b). In fact, managing ecological processes at the landscape level may be just as important as management decisions taken at the intervention site level, especially for delivering Nature Contributions to People and therefore, the long-term assessment, planning, implementation and monitoring of SSM practices require landscape-scale approaches and integrated implementation and monitoring of site-specific measures (IUCN, 2020b). It could be considered that criteria 1, 2, 3, 4, 5, 6, 7, 12, 13 and 14 are more related with larger scales and criteria 8, 9, 10, 11 are more closely related to the specificities of the sites.

Argentina and Thailand have been included in the assessment in order to have a representation of non-EU sites. West Cameroon was the only site which was not included in the assessment due to time limitations.

4. Conclusions of the assessment

The following chapter presents the main conclusions of the evaluation of SSM practices based on the 14 assessment criteria. The assessment process is described in Chapter 5, the results of the assessment are presented in Chapter 7 and the assessment tool and criteria is included in Appendix A. To analyse the results of the assessment the average and standard deviation of the scores was calculated for each criterion (see Table 2).

Table 2. Results obtained for the assessment, including the average and standard deviation per criterion

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

Criteria		Average	Standard Deviation
Influences and impacts	SSM practices respond to the current state of the ecosystems and soil biodiversity	1	0,3
	SMM practices recognises and responds to the interactions between the economy, society and ecosystems and integrate complementary interventions	1	0,9
	Risks and trade-offs are identified, managed, and inform corrective actions and safeguards	1	0,8
	SSM must address societal challenges that have been identified, thoroughly understood, and well-documented	2	0,7
	SSM practices have a positive impact on soil biodiversity and ecosystem integrity and the impact is periodically assessed	1	0,4
	SSM practices have a positive impact on human wellbeing and the impact is periodically assessed	0	0,5
Beneficiaries	The stakeholders and beneficiaries have been identified and governance processes are participatory, inclusive, transparent and empowering	1	0,3
	The rights, usage of and access to land and resources, along with the responsibilities of different stakeholders are acknowledged and respected	1	0,7
	SSM practices are economically viable	1	0,7
Responses	Lessons learned are documented and shared	1	0,7
	SSM practices are managed adaptively, based on iterative learning	1	0,5
	A monitoring and evaluation plan is implemented to assess unintended adverse consequences on nature and review the established safeguards.	1	0,7
	Relevant policies, regulation frameworks and national and global targets are identified and considered in the SSM practices design	2	0,7
	SSM practices inform and enhance facilitating policy and regulation frameworks and contribute to national and global targets	2	0,7

The criterion that has the lowest score, and the only one with an insufficient value on average, is the one related to SSM practices having a positive impact on human well-being, and this impact being periodically assessed. This was due to beneficiaries, human wellbeing outcomes, specific indicators and benchmarks (specially at local scale) not being identified, a lack of resources and monitoring activities. Specifically, there is insufficient research specifically addressing the correlation between soil management and human well-being. The identification of beneficiaries is vague and lacks specific monitoring metrics regarding the implementation, adoption, and benefits of SSM practices. Additionally, human well-being outcomes are either unidentified or vaguely defined, lacking clear benchmarks and provisions for assessment. There are no local benchmarks to monitor impacts on human well-being outcomes, and priorities may differ between global and local scales. While positive impacts on human well-being are generally acknowledged in basic research, benchmarks, assessments, and strategic initiatives remain minimal due to limited political interest, as these benefits are challenging to express in monetary terms. Exploring the relationship between sustainable management practices and the nutritional value of the food produced could be a working line to move forward.

There are three criteria with an adequate average score. The first one is the criterion related to SSM, which must address societal challenges that have been identified, thoroughly understood, and well-documented. The outcomes of the assessment point out that, there are still significant knowledge gaps due to insufficient documentation and a lack of context-specific information about societal challenges at the local scale. This is particularly notable considering that the main challenges may differ at various scales. The third criterion involves the identification and consideration of relevant policies, regulatory frameworks, and national and global targets in the design of SSM practices. The fourth criterion, with

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

an adequate average score, is related to how SSM practices inform and enhance the facilitation of policy and regulatory frameworks, contributing to national and global targets. These two aspects related with policy and target reporting will be further developed in T6.2 and D6.3. Even if the average score for these criteria is adequate, there is a significant margin for improving the performance of interventions in these aspects. This is noteworthy, especially considering that some of these criteria closely linked with how SSM practices positively impact human well-being, which happened to receive the lowest score.

On the other hand, most of the criteria have a partial score on average. The scores for the two criteria that address how SSM practices respond to the current state of ecosystems and soil biodiversity, as well as how stakeholders and beneficiaries have been identified and involved in governance processes, are either partial or almost entirely partial in every case. Therefore, there was a very homogeneous result across the regions. The criterion referring to how SMM practices recognize and respond to the interactions between the economy, society, and ecosystems and integrate complementary interventions is the one with higher dispersion in the scores and less homogeneity across the region. This may suggest that the lessons learned from some regions could to contribute to enhancing a greater alignment with this criterion in other cases.

It should be highlighted that a lack of human and economic resources are the main barriers identified, preventing a higher score in several of the criteria.

The criteria that address economic viability, the identification and management of trade-offs, governance aspects, and the interaction between economy, society, and ecosystems are specifically related to how a just transition to a more sustainable production system can be achieved. Specific guidelines on this will be developed in D6.2 and D4.2.

Table 11 shows the results of the assessment process and highlights how well the criteria have been met by the SSM practice in each region (strongly, adequately, partially, or insufficiently).

Table 3. Results obtained for the assessment per region

SSM practice	**Organic farming**							**Grass mixes**	**Continuos cover**
Criteria	**AR**	**LV**	**DK**	**ES**	**HU**	**BE**	**TH**	**IE**	**FI**
SSM practices respond to the current state of the ecosystems and soil biodiversity	Partial	Partial	Partial	Adequate	Partial	Partial	Partial	Partial	Partial
SMM practices recognises and responds to the interactions between the economy, society and ecosystems and integrate complementary interventions	Partial	Partial	Adequate	Insufficient	Insufficient	Partial	Insufficient	Adequate	Adequate

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

Risks and trade-offs are identified, managed, and inform corrective actions and safeguards	Partial	Partial	Partial	Adequate	Insufficient	Adequate	Insufficient	Adequate	Adequate
SSM must address societal challenges that have been identified, thoroughly understood, and well-documented	Partial	Partial	Adequate	Partial	Adequate	Partial	Partial	Strong	Adequate
SSM practices have a positive impact on soil biodiversity and ecosystem integrity and the impact is periodically assessed	Insufficient	Partial	Partial	Partial	Insufficient	Partial	Partial	Partial	Partial
SSM practices have a positive impact on human wellbeing and the impact is periodically assessed	Insufficient	Partial	Partial	Insufficient	Insufficient	NA	Partial	Insufficient	Partial
The stakeholders and beneficiaries have been identified and governance processes are participatory, inclusive, transparent and empowering	Partial	Partial	Partial	Partial	Partial	Partial	Insufficient	Partial	Partial
The rights, usage of and access to land and resources, along with the responsibilities of different stakeholders are acknowledged and respected	Insufficient	Adequate	Partial	Partial	Partial	Partial	Insufficient	Partial	Adequate
SSM practices are economically viable	Insufficient	Partial	Partial	Insufficient	Adequate	Partial	Partial	Partial	Adequate
Lessons learned are documented and shared	Partial	Adequate	Adequate	Partial	Adequate	Partial	Insufficient	Adequate	Partial
SSM practices are managed adaptively, based on iterative learning	Insufficient	Partial	Partial	Partial	Insufficient	Partial	Insufficient	Partial	Partial
A monitoring and evaluation plan is implemented to assess unintended adverse consequences on nature and review the established safeguards.	Insufficient	Partial	Adequate	Partial	Partial	Adequate	Insufficient	Partial	Partial
Relevant policies, regulation frameworks and national and global targets are identified and considered in the	Adequate	Adequate	Partial	Adequate	Adequate	Partial	Partial	Adequate	Strong

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

SSM practices design									
SSM practices inform and enhance facilitating policy and regulation frameworks and contribute to national and global targets	Partial	Adequate	Adequate	Partial	Adequate	Adequate	Partial	Adequate	Strong

As reflected in IUCN, 2021, the assessment process faces several challenges.

5. Results of the assessment

The first section (7.1) includes a general description of the SSM practices considered in each region, the involved stakeholders, and the overall context at the regional and national levels in which they are integrated, including a brief description of the objectives, impacts, and social challenges related to each SSM practice. The subsequent sections of Chapter 7 describe the evidence identified to justify the scoring for each of the criteria as well as the barriers that prevent each criterion from being met to a greater extent. It should be noted that the topics addressed in the IUCN Global Standard for NbS, which were thoroughly examined in other WPs (WP2, WP3, and WP4), have been developed with more detail.

5.1. General information

Latvia

The case assessed in Latvia (Figure 4) are organic farms with diverse crop rotations that are in production since 2003 in Skrīveri. Farm practices include ploughing in the 20-24 cm, organic fertiliser amendments such as compost and manure, and application of plant growth promoters. Organic agriculture is a rapidly expanding market in Latvia and is playing a crucial role in addressing various challenges associated with sustainable production. In this regard, 13.91% of cropland is certified organic.

The climate in Latvia is temperate continental. The population density is lower than in much of Europe and large parts of Latvia are covered by forests and agricultural pastures. The development of the organic sector is quite closely connected with the history of Latvia. The area under organic farming started to increase since late 1980s, when farmers gained access to their own, private land. The main organic products produced in the Latvian market are milk, cereals, cattle, potatoes, honey. Dairy products and cereals (mainly oats and buckwheat) are the strongest sectors for domestic products. Some farmers also produce organic fruit, berries, fish, eggs and poultry, vegetables, among others.

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

Figure 4. Winter wheat field located in Latvia, belonging to the SOILGUARD cross-biome network of sites

One of the main objectives of organic farming is to enhance soil and environmental health. The potential benefits of these management systems include the maintenance and improvement of soil biodiversity, as well as the conservation of landscape and lifestyle, while reducing nitrogen and pesticide leaching.

The key stakeholders involved in this assessment encompass farmers, agricultural suppliers, landowners, farmer organizations, researchers, advisors, consultants, policymakers, and consumers

Middle Jutland, Denmark

The SMM assessed in Denmark (Figure 5) are organic spring barley farms in Central Jutland and Funen with at least two years of organic certification which integrates diverse crop rotations, hedges and continuous cover as farming practices.

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

Figure 5. Spring barley field located in Central Jutland and Funen located in Latvia, belonging to the SOILGUARD cross-biome network of sites

Denmark is a low-lying country with a cool, wet climate and more than 60% of its land area is agricultural. Therefore, there is a relatively high loosing potential of pesticides and nitrogen from cultivated fields to the environment. With the aim of reducing the inputs of synthetic pesticides and fertilizers, there is significant national motivation for organic production. In addition to not using pesticides, organic farms typically incorporate organic-based fertilisers with lower nitrogen loads, and use more diverse crop rotations and catch crops. These combined strategies decrease the flow of synthetic amendments to waterways and the environment, and also can support the holistic wellbeing of the farming enterprise. To assess the impacts of organic farming on soil biodiversity, this study sampled soils from 10 old organic farms (more than 5 years of certification), 10 young organic farms (between 2 and 5 years of certification), and conventional farms. In 2022, all farms cultivated spring barley in Central Jutland or Funen, Denmark.

Organic farming is significant in Denmark, with more than 300.000 ha, or 12%, of cropland being certified organic. The direct stakeholders involved in this assessment include the farmers that provided access to their sites for sampling. This research applies to an additional larger network of stakeholders, including agricultural suppliers, landowners, farmers, farmer organisations, researchers, advisors, consultants, regulators, policymakers, and consumers. Denmark has the largest organic market share in the world of retail food products, at around 13%. Thus, organic food production plays an important role in the Danish food system.

Organic farming addresses many challenges related to sustainable production. In Denmark, organic farming has been shown to reduce nitrogen and pesticide leaching to waterways, and improve the biodiversity of plants, and pollinators on farms. Overall, organic farming in Denmark has shown good potential to improve the resiliency of farms in the face of environmental and societal change.

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

The objectives of the intervention are to improve soil and environmental health, in addition to food nutritional content and farmer wellbeing by not using pesticides nor synthetic fertilizers. More findings are to come on other aspects related to soil health and soil biodiversity from WP2 and WP3.

Region de Murcia, Spain

Organic rainfed farms for cereal production have been assessed in Murcia (Figure 6). This analysis involves mainly the general patterns found in 10 plots with organic management in the NUT-2 Region of Murcia (with at least 5 years of organic farming).

This region ranges from sea level up to 1350 meters above sea level. It has an average annual rainfall of 325 mm and mean temperatures of 19 °C, but summers can reach up to 45 °C. The plots' soils are originated over calcareous materials (marl and limestone), they cover several degradation statuses from low/medium to medium/high according to evidence of soil erosion, colour and aggregation.

Figure 6. Organic farms for cereal production located in Murcia, belonging to the SOILGUARD cross-biome network of sites

Agriculture and soils in these semi-arid ecosystems are facing more intense impacts of climate change, marked by increased occurrences of droughts and heatwaves. This raises the risk of crop losses, especially in systems without irrigation. In this regard, the primary objective of SSM is to enhance soil resilience in response to climate change, ensuring the preservation of nutritious food sovereignty. The priority impact is to foster more diverse and resilient Murcian agro-ecosystems through improved management of agricultural practices, aimed at slowing down soil erosion and desertification, while enhancing carbon stocks in the plots.

Stakeholders and beneficiaries involved include land users and farmers, farmer associations (e.g. UPA, SEAE, COAG, Asociación Agraria de Jóvenes Agricultores), agricultural company (v.g. AgriTech Murcia), agricultural public administrations (e.g. Consejería de Agricultura y Agua de Murcia, Consejo de Agricultura Ecológica de la Región de Murcia), civil asociations (e.g. TRAMCE, CARBOCERT, BIOVITI, IDEAS, Bio Vibrant, GIRASOIL), advisory services (e.g. ASAJA Murcia, UPA Murcia, FECOAM), and NGO (e.g. ANSE and Amigos de la Tierra).

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

Southern Ireland

Intensively managed agricultural grasslands have been assessed in Southern Ireland (Figure 7). The SSM approach in this region are grass mixtures with reduced inorganic fertilization with the objectives of the intervention is to increase the soil biological health of the system and by doing so, increase soil function and resilience of agricultural grassland systems.

Grasslands is the predominant crop type in Ireland. Often grasslands are re-seeded with highly productive, low diversity grass monocultures such as *Lolium perenne*. However, increasingly there is interest in diversifying swards to include a mixture of legumes, herbs and grasses. Previous research has indicated that these more diverse swards can have increased productivity, nitrogen use efficiency, lower environmental losses and increased drought resistance and resilience. Thus, their use can enhance food security, reduce greenhouse gas production from soils, and enhances water quality. Mixtures have also been shown to be more drought resistant and resilient and may be an important measure for climate adaptation. Further, more diverse swards also have better soil structure which may reduce the risk of erosion, land degradation, flooding, and act as a better habitat for soil biodiversity.

So, the comparison in this study is between a low diversity grassland system, which is often associated with high N inputs, and a more diverse system, which is often associated with low N inputs. Sites sampled had paired treatments so that each farm had both the low diversity and the high diversity system on the same soil type. Five of these paired sites were classified as low soil degradation and five were classified and medium soil degradation. However, we have some concerns whether the modelled degradation status, which is mainly based on erosion risk, is reflective of degradation risk in situ. Compaction is often the greatest degradation risk in Irish systems, particularly on heavier soils, and this is not encompassed in the modelled risk.

The SSM approach considered here has the potential to be employed on a large national scale where agricultural grasslands are managed intensively. Stakeholders involved in the design and implementation include the farmers (and their agricultural advisors) that applied the management option to their farms, and thus provided the sampling sites. It also includes the researchers who have previously investigated the impact of diversifying swards. Stakeholders that benefit from the research outcomes include more than 110,000 Irish farmers, agricultural advisors, policy makers, consumers, regulators, farm organisations, farmer educators, researchers, and stakeholders interested in enhancing soil health and farmland biodiversity. As well as the benefits to the environment, the reduced nutrient inputs required by more diverse swards have an economic benefit for the farmers and the increased resistance to drought will result in a more climate resilient farming system which will underpin food production.

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

Figure 7. Grass mixtures located in the south of Ireland, belonging to the SOILGUARD cross-biome network of sites

South Transdanubia, Hungary

The SSM approach in the Hungarian region is organic crop production, active since 2018 in Nikla. In that year, organic farming replaced conventional crop production primarily due to the observed decline in soil fertility, resulting in the inefficiency of intensive soil management technologies and an increased cost. Organic field management is less intensive, applies less fertilizers and use of synthetic pesticides is not allowed. This farming system is less cost-intensive, yielding lower outputs. However, organic products command higher and more stable prices in the market. Therefore, the decision to adopt organic farming was primarily driven by economic considerations rather than ecological convictions.

The main stakeholder is the farmer who implemented organic crop production in the field. Another organization involved is Bio Garancia Ltd., an accredited certification body. Bio Garancia provides farmers, processing plants, and traders in the food industry with necessary information for obtaining organic certification. This contribution aims to introduce sustainable production methods and strengthen the position of certified companies in the market. Additional beneficiaries include university students who can gain insights into organic agriculture through field visits and research conducted at this study site. The broader beneficiaries encompass the ecosystem and society, benefitting from the absence of synthetic pesticides and fertilizers in the environment, leading to enhanced biodiversity and ecosystem services, as well as providing pesticide-free food.

The primary societal challenges addressed in this case involve stabilizing profitability, enhancing biodiversity, ensuring food safety, and reducing chemical contamination. Addressing the low profitability of farming could be achieved by securing higher and more consistent market prices for organic products, along with the possibility of claiming increased subsidies. To mitigate the risk of synthetic pesticide residues in the environment and food, this approach aims to promote higher biodiversity and wildlife while addressing weed infestation more effectively in the fields with a less intensive yet more profitable utilization of soil fertility.

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

Western Finland

The SSM approach in the Finland region is based on the replacement of Rotational Forestry (RTF) with Continuous Cover Forestry (CCF) with selection cutting and gap cutting on fertile forest sites (Figure 8).

Rotational forestry, based on clearcutting, is the overwhelmingly predominant management system in the southern part of the boreal forests in Fennoscandia. It is based on clearcutting the existing forest over an area of 0.5-20 hectares and replacing it by a planted monoculture through planting in most cases. The new tree generation is managed for uniformity and high stem wood production, and clear-cut occurs again at the end of a 60 to 100-year rotation.

The intervention involves R&D on alternative management systems that support continuous tree cover on the site. It employs harvesting practices to better facilitate the formation and retention of soil organic material and living roots, fostering life and biodiversity belowground and sustain the assemblages that do not survive the drastic change in the environmental conditions and niches caused by clearcutting both below and above ground.

Figure 8. Forest area located in Western Finland, belonging to the SOILGUARD cross-biome network of sites

The DISTDYN initiative (Koivula et al., 2014), was used in the SOILGUARD project as the Finnish case study, including data sourcing for WP2. This initiative, about forest management practices based on natural disturbance dynamics, is pursued since 2009 on two large forest areas (1000 hectares each), of which the Isojärvi area with its fertile sites dominated by Norway spruce (*Picea abies* Karst). The silvicultural systems are based on selection and gap harvesting with the inclusion of the benchmark clearcutting. The DISTDYN project was designed and launched in cooperation with Metsähallitus (the agency responsible for the governance and practical management of state-owned forests in Finland), Natural Resources Institute Finland (Luke), and the universities of Helsinki and Eastern Finland. Metsähallitus with some 3.5 M ha of productive forest land (a 17-% share of productive forest land in Finland) is obviously the most direct beneficiary of the R&D work, and it also provides the research

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

areas. It is also part of a large governmental METSO initiative for enhancing biodiversity in forest ecosystem through the establishment of reserves and R&D around CCF.

During its first 14 years of implementation, DISTDYN has contributed to the development of CCF methods and applications in Finland, including research methodology, results, and application. The basics concepts were involved as building blocks in the initiative that resulted in the lifting of legal restrictions to CCF in the 2014 Forest act. Metsähallitus has taken major steps forward in the use of CCF by stepping up its share to 25% of harvesting in mature stands, and establishing an even larger experimental setup together with researchers.

The results and applications in reverberate throughout the forestry and ecological sectors of governance, business, extension, and research and development, with potential for large-scale transformations concerning carbon balances and sequestration, protection of biodiversity and ecosystem services, timber yields and industries, and the multiple uses and benefits of functioning forest ecosystems, regardless of ownership. For instance, some 57 % of private non-corporate forest owners already apply CCF in all or part of their forests in Finland.

CCF tackles challenges brought about by the predominant high-intensity RTF system related to climate change mitigation and adaptation (particularly carbon balance and sequestration in forest ecosystems), economic and social development (sustainable productivity of forests in terms of timber yields, multiple use (amenity, recreation, non-wood products, non-material benefits), and various ecosystem services, environmental degradation, and loss of environment and biodiversity.

The intervention involves R&D on alternative management systems that support continuous tree cover on the site (CCF). It employs harvesting practices that better facilitate the ecological and societal sustainability of forest management and utilization in Fennoscandia. In terms of soil biodiversity and ecosystem integrity, the alternative systems are expected to make major contributions to the formation and retention of soil organic material and living roots, fostering life and biodiversity belowground and sustain the assemblages that do not survive the drastic change in the environmental conditions and niches caused by clearcutting both below and above ground.

West Flanders, Belgium

In Belgium, the assessment considered 10 organic farms in West-Flanders, under organic management for at least 4 years.

The food production and farm management system combines environmental best practices, the conservation of natural resources, the application of high animal welfare standards, and production tailored to the preferences of certain consumers who seek products made with natural substances and processes. In this regard, organic farms must fulfil a described set of criteria in order to be certified organic farms. Two main types of organic farms are considered.

There are two main types of organic farms. The first type consists of large organic farms that produce bulk products, such as potatoes and vegetables, for major supermarkets. These farms typically feature expansive fields and employ high levels of mechanization. While non-inversion tillage is often the norm, ploughing still occurs. Weed control is frequently executed through mechanical weeding. The second type of organic farms is Community-Supported Agriculture (CSA) farms. These are smaller

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

farms with a diverse range of crops, often cultivated on small fields or even with several crops on the same field. These farms directly sell their produce to customers or at farmers' markets. CSA farms are characterized by an intensive use of manual labour.

Organic farms in this context encounter numerous challenges, including the low profitability of conventional farming and the employment of non-sustainable production methods (such as the gradual loss of soil organic carbon, soil compaction, and erosion) in conventional farming practices. In response to these challenges, organic farming management is being developed with the aim of implementing more sustainable approaches to the management of agricultural capital and soil. This shift may positively impact biodiversity but could also lead to a decrease in overall production.

Main stakeholders involved are farmers, farmers' associations (such as Bioforum), retailers and the general public.

Pampa Region, Argentina

Several organic plots for cereal production in the Southeast of Buenos Aires Province were examined in the Argentinian case (Figure 9). The plots have been under organic agriculture for at least 3 to 5 years, with two fields practicing this method for 12 and 22 years, respectively. The organic farming practices involve croplands, crop rotation, organic amendments in some cases, and the complete avoidance of any chemical inputs, including fertilizers and pesticides.

Organic agriculture has been promoted to address land degradation, food security, environmental degradation and biodiversity loss. Organic production has as its objectives the protection of the environment and the climate, the conservation of soil fertility, the maintenance of biodiversity, respect for natural cycles and animal welfare, the non-use of synthetic chemicals and the non-use of GMOs.

Organic production in Argentina is very low compared to conventional production (3% of agricultural establishments), but it has shown a sustained increase every year for more than a decade. During the year 2022, the organic area harvested grew by 14%, harvesting 109987 hectares in total. The main destination of Argentine certified organic production continues to be exports (mainly the United States and Europe). In Argentina, organic agriculture is regulated through the National Law on Ecological, Biological, or Organic production.

This agricultural model is based not only on economic profitability, but also on environmental, social aspects, land occupation, food quality and appropriate and independent technologies, characterized by a permanent and open debate of the productive systems adopted by each farmer; debate that takes into account, in a comprehensive manner, the technologies and machinery adopted, the yields obtained, the environmental considerations and care of the soil, water and biodiversity, the social structure of the rural company and the economic results.

The stakeholders and beneficiaries involved are: 1) the enforcement agency for this law is the National Agrifood Health and Quality Service (SENASA), a government agency, 2) farmers, 3) groups of farmers (e.g. Pampa Organica, the first Group of Extensive Certified Organic Producers in Argentina), 4) certifying entities (e.g. ECOCERT.com), 5) NGOs and 6) consumers.

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

Figure 9. Organic cereal crop located in Southeast of Buenos Aires Province, Argentina, belonging to the SOILGUARD cross-biome network of sites

Chiangrai, Thailand

An organic rainfed plots for rice production in Chiangrai was evaluated in the Thai case (Figure 10). Those plots are located in the Northern region of Thailand in the Chiangrai Province, District of Phan, Wiangchai and have been organically managed for at least 5 years. The plots are organic farms in paddy rice field with organic amendment. The objective of the intervention is to increase the soil biological health of the system and by doing so, increase soil function and resilience of agricultural paddy rice systems, based in a better management of agricultural practices to slow down soil erosion and desertification, and improve the carbon stocks in the plots.

Most of the terrain surrounding Chiang Rai town is either flat or has moderate hills. The exception is outward in the west and north-west directions, where limestone hills are evident, some of which have vertical exposed cliffs. The land use area of Chiang Rai is covered by cropland (61%), artificial surfaces (26%), and shrubs (13%). The most important crops grown in Chiangrai are rice, cassava, potato, orange and onion with area of 10.26, 1.67, 0.27, 0.24, 0.06 %. That production of 5 main crops is 4.02, 17.98, 18.66, 11.62 and 23.08 tones/hectare. The average price in 2021 of 5 main crop were 9,540 baht/ton, 2.07 baht/Kg., 12.31 baht/Kg., 21.69 baht/Kg. and 7.40 baht/Kg. Thailand selected rice for site study where grown glutinous and non-glutinous rice. Organic rice price in Thailand normally more than conventional rice price about 100% but yield of organic rice lower than conventional 25%. Sixty three percent of organic rice was domestically consumed and another 37% was exported in (according to the data of 2018).

Rice is an important economic crop that generates income for the country not only general rice but also organic rice. Also, rice is a staple food for Thai people and people in many countries around the world. In 2017, Thailand expanded its organic production areas from 6,400 ha to 16,000 ha. Given that the current and emerging trends of organic rice production, government agencies continued facilitating farmers to fulfil control and monitoring based international standards of organic agriculture such as the International Federation of Organic Agriculture Movements (IFOAM), the United States Department of Agriculture (USDA), and the Organic Standards of the European Union (Council Regulation; EC). Moreover, a separate body of related agencies contact farming practices as such as the Rice Department, the Ministry of Agriculture and Cooperatives in association with the Ministry of

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

Commerce allows for the use of organic rice certification marks to the selected organic rice-producing farms (Department of Foreign Trade, 2019). Therefore, the Department of Internal Trade, Ministry of Commerce the basic supplier of paddy. All of them were found to be having a common organic rice gathering point for members of the farmer groups. These farmer groups were consisted of only those farmers where organic rice farming cultivation was done by use of green manure, compost, and the approved natural organic substances, while without any use of chemicals, chemical fertilizers, and pesticides including those insecticides, fungicides, and herbicides. Organic rice production was randomly verified by the internal audit committee in compliance with Organic Agricultural Certification Thailand (ACT) standards. Most of the amount (50%) of organic rice production was sold to mill of exporter/contractors while, 30% amount of organic rice production was sold to farmers group collectors (which involves the processing of paddy rice by their own rice mills and after that gone through the processes of packaging to exporters) and exporters and the remaining 20% within contact farming was sold to general mills and others.

Thai rice is considered a victim of extreme weather events and greenhouse gas emissions have contributed to climate change. This is because rice cultivation emits greenhouse gas from three factors: Emissions from burning crops for preparing the plots, methane emission from water consumption, and carbon dioxide in the soil.

Figure 10. Organic cereal crop located in Southeast of Buenos Aires Province, Argentina, belonging to the SOILGUARD cross-biome network of sites

5.2. Influences and impacts

Results documented in D3.2 show that in general, sustainable management regimes enhanced several of the 13 ecosystem indicators measured but the result are very region specific. Sustainable management had a positive effect, although marginal, on biodiversity, and particularly evident in sites with comparatively low soil organic carbon (i.e. sites in Belgium, Denmark, Spain and Hungary). All soil functions studied showed significant interactions involving soil biodiversity, management regime, and/or simulated drought. This shows the prevalent role that soil biota plays in mediating the response of soil functioning to management or climate.

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

5.2.1. *SSM practices respond to the current state of the ecosystems and soil biodiversity*

Latvia

Limited information is available regarding the implications of organic farming at the landscape scale, especially its effects on biodiversity and ecosystem degradation. While some studies have explored the impact of organic farming on soil health, biodiversity, and climate at smaller scales or individual farms, these findings are often constrained to specific locations and lack scalability to regional or national levels. In this regard, coordinating funding for comprehensive large-scale research aimed at monitoring ecosystems and biodiversity across various trophic levels poses a significant challenge.

Middle Jutland, Denmark

There is little information on the landscape-scale implications of organic farming and how it specifically impacts biodiversity and ecosystem degradation. There have been studies conducted on smaller plots or farms on the impacts of organic farming on soil health, biodiversity, and climate, but the results are typically localized and not scalable to the regional or national level. This is because it is difficult to coordinate and fund large scale research that monitors the state of ecosystems and biodiversity at different trophic levels.

Region de Murcia, Spain

Despite having characterized 10 farms with organic management and complementary literature, a stratified sampling based on SSM practices and soil types is required at the NUTS Region scale. Additionally, it is crucial to consider farms with more than 5 years of experience in organic farming. Certain trends were identified based on management practices in combination with degradation status, including factors such as organic matter, water holding capacity, and basal soil respiration. Parameters like bacterial biomass and bulk density may vary depending on the type of parent material in this Mediterranean climate zone.

In this regard, the main barriers include a lack of funding for conducting sampling and laboratory analyses, as well as challenges in collecting soil samples from a larger number of producers.

Southern Ireland

There is still limited information about the biological health of reduced diversity grassland systems, which predominate in intensively managed grassland systems in Ireland. Observationally, farmers are reporting improved structure and enhanced earthworm populations with more diverse swards, and for some farmers this has become an incentive to change the sward composition. Primarily, however the driver for the change in management is associated with agronomic and economic benefits such as reduced fertiliser requirements and increased drought resilience. Some research is available on individual sites demonstrating soil biodiversity benefits as linked to the change in management. However, larger scale assessment at farm, landscape and national level is still lacking. Data from WP2 will add to this. It has to be considered that there is currently insufficient data available on the soil biological status at all scales, and the available data is limited to certain ecological groups

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

South Transdanubia, Hungary

The current state of ecosystems and the comparison between conventional and organic crop production was validated through field visits and input gathered from local knowledge and the farmers. However, the information available may not be sufficient to make general conclusions at wider scales.

Western Finland

Current state of ecosystems is routinely and continuously monitored throughout Finland, but based on just a few key characteristics related to above-ground species assemblages and habitats. The 30-year biodiversity-management paradigm has focused on above-ground features and simplistic solutions and there is a lack of research and resources in the soil context.

Soil issues are all but ignored, and the specific knowledge base is undeveloped. However, the main drivers in soil ecosystems have been identified and remedies designed relying on basic soil science, but need to be locally verified to enhance credibility and impact. This work is in progress also in the DISTDYN NbS venture.

West Flanders, Belgium

Soil biodiversity is considered, but primarily at a field level, and only a few indicative species are taken into account. On many farms, non-inverting tillage is employed, partially to enhance the population of rainworms (Lumbricus Terrestris), as it has, among other benefits, a positive impact on soil structure, water infiltration, and various other factors. The rationale supporting this practice is to let the worms handle the tilling work for the farmer.

The main barriers for implementing SSM practices that respond to the current state of the ecosystems and soil biodiversity is 1) the lack of knowledge, since soil biodiversity status (except for rainworms) is not known and thus not taken into account, 2) management requirements, for example, ploughing is sometimes needed for preparing the seedbed is required after grass or catch crops for instance and 3) buyers demands, since large buyers demand harvest at a specific time, even when weather conditions are not favourable for harvest.

Pampa Region, Argentina

Although there are studies that evaluate different aspects of the impacts of organic agriculture on soil health and biodiversity, the results are usually localized and are not sufficient to obtain general conclusions or extrapolated to other scales. In the particular case of this study, for a heterogeneous region like the south of Buenos Aires, 10 sampling sites are not enough to obtain robust conclusions about the effect of this practice on soil health and its biodiversity. On the other hand, there is also heterogeneity in the practices covered by organic agriculture, as well as in the time since this SSM was implemented. However, the information collected supported by existing literature will serve to obtain preliminary conclusions.

The main barrier hindering a higher alignment with this criterion is the logistics and budget required to obtain a greater number of samples, covering various practices in different contexts. This limitation affects the ability to extrapolate results more comprehensively.

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

Chiangrai, Thailand

Thailand has now entered the second stage of its assessment process: evaluating existing knowledge on biodiversity and ecosystem services, guided by the key policy questions identified during the scoping stage. The main barrier for achieveing a higher score on this criterion is the lack of budget and human resources to deploy an edaphic biodiversity monitoring campaign on an adequate scale.

5.2.2. *SMM practices recognises and responds to the interactions between the economy, society and ecosystems and integrate complementary interventions*

According to the results in D3.2 the vast majority of soil functions evaluated were positively correlated between each other. These functional synergies between ecosystem indicators remained relatively consistent even when imposing the experimental drought. However, a very large proportion of these synergies disappeared when filtering by the effect of Management, suggesting that multiple ecosystem functions can be more difficult to maintain simultaneously at high levels within a given agricultural management (either sustainable only, or conventional only).

Additionally, soil biodiversity also plays an important role in modulating the responses to soil functioning to shifting agricultural management since it appears that organic farming has more positive effects on functioning if coupled with an enhanced soil biodiversity than alone.

Latvia

The assessment of the current status of ecosystems and the comparison between conventional and organic crop production was validated through on-site visits and consultation with local farmers. Additionally, alignment with the latest CAP objectives was taken into account.

However, the precise determination of interactions and synergies remains unresolved. There is a knowledge gap of organic crop production among many farmers. The higher prices associated with organic products often go unrecognized by a significant part of consumers, potentially constraining the expansion of organic production in the face of competition with conventional alternatives.

Middle Jutland, Denmark

There is a relatively strong collaboration between research organisations, policymakers, farmer cooperatives, farm advisory services, and farmers. There is a specific centre dedicated for improving organic farming, namely the Innovation Centre for Organic Farming. There are also two other organizations, Organic Denmark and the International Centre for Research in Organic Food, that support the market development of the organic food sector. These centres work together across disciplines to assess consumer preferences and innovation in regards to both food and agricultural production. The main barrier to better fulfilling this criterion is the absence of data from projects investigating the social, economic, and environmental impacts of organic farming.

Region de Murcia, Spain

Limited previous research in the region has been devoted to understanding the economic and cultural relationships with SMM practices and nature's contributions to people, and a general lack of

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

information has been identified among citizens. The perception surveys generated from this work do not directly contribute to filling this gap.

Southern Ireland

The intervention takes into account environmental, economic and societal needs. More diverse grasslands require lower N inputs, which is an economic benefit for the farmer. Lower nitrous oxide emissions and nitrate leaching are associated with the intervention resulting in environmental benefits. Increased resilience to climate stress results in increased resilience of the food security and there are some indications of increased soil health which should bring increased soil functions and greater resilience to soil stress. However, additional data is needed on environmental, economic and societal benefits. Also, there are some practical issues (for e.g. concerns about herb persistence, weed control, potential animal bloat, and sward establishment/management) that need to be overcome to facilitate wider adoption.

South Transdanubia, Hungary

Interactions and synergies have not been determined precisely.

Western Finland

Interactions between the economy, society and ecosystems are one of the key R&D objectives in the DISTDYN venture, including landscape-scale effects of CCF applications. The SSM practices are designed for general applicability throughout the region and beyond (Nordic boreal forests). Acknowledgement of the complexity of the silvicultural, ecological, economic, and social perspectives of the intervention (CCF instead of RTF) is paramount at all stages.

The needed time for identifying and elaborating a response to interactions and integrating complementary interventions takes much more time in forest ecosystems than in crop systems, with a time scale of several decades, not just a few growing seasons. Stakeholder reluctancy to admit the weaknesses of RTF and the need to establish balances between complementary approaches and interventions is one of the main barriers to better achieve this criterion.

West Flanders, Belgium

SSM practices take into account effects on crop yield, soil erosion (mainly loss of fertile soil but also effects on neighbouring parcels, roads…), water quality (nitrate leaching, phosphate). Erosion reduction and nitrate leaching, phosphate leaching/runoff reduction is enforced by legislation.

Recognizing the interactions between the economy, society, and ecosystems and integrating complementary interventions for reducing nitrate leaching or erosion requires specific infrastructure, which is not always available. Achieving nitrate leaching reduction through SSM practices demands a detailed understanding of soil nitrogen dynamics, given that soils are still largely a black box, and expensive soil nitrate measurements. Erosion reduction, sometimes requires adapted cultivation practices for which suitable machinery is not always available. Moreover, not all farmers have control over crucial management decisions, such as harvest dates, due to external pressures that can lead to suboptimal decisions from a sustainability perspective.

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

Pampa Region, Argentina

There is little precedent in the area that identifies interactions between economy, society and ecosystems, much less work that includes long-term monitoring. The main monitoring work of organic productive systems on a national scale is carried out by SENASA (National Agrifood Health and Quality Service), but they are focused on productive, economic and social aspects. In the particular case of this study, the interviews carried out with farmers in the fields studied partly address these interactions. A transdisciplinary team is required to address these aspects. Added to the fact that organic agriculture in the study area is implemented by very few farmers, therefore research in this field is insufficient.

Chiangrai, Thailand

No relevant data has been integrated regarding SSM's the economy, society, and ecosystems. Data collection and more experiment should be developed.

5.2.3. *Risks and trade-offs are identified, managed, and inform corrective actions and safeguards*

Latvia

Risks and trade-offs are identified, but consequences and risks of the large-scale implementation of organic crop production is not directly understood both locally and globally. The lack of funding and human resources are the main barriers that prevent a higher alignment with this criterion.

Middle Jutland, Denmark

The handling of risks and trade-offs associated with organic soil management to inform corrective actions remains unclear. While there are studies on the impacts of using organic-based fertilizers and weed management without herbicides, there is insufficient evidence to guide decision-making. There is a notable lack of data on the risks and trade-offs of organic farming, especially its effects on soil biodiversity.

Region de Murcia, Spain

The main large-scale risks have been identified by producers and researchers. These include an increasingly changing climate with rising occurrences of droughts and heatwaves, as well as rural depopulation, which has been identified as an external risk. Although there is already a public weather monitoring and warning system, the challenge of rural depopulation has not yet been addressed. Internal risks necessitate further research on a regional scale.

Southern Ireland

A wide range of studies have been undertaken to investigate the agronomic impacts of the intervention. Risks, including species persistence, weed management, and animal bloat, have been identified. Research has been conducted (and is ongoing) to develop guidance to mitigate these risks. Additionally, farmers have actively tested and modified these interventions on their own farms. So far, no trade-offs have been identified concerning environmental and economic aspects. The soil biological benefits remain poorly understood, but data produced in future tasks of SOILGUARD will enhance the available knowledge.

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

South Transdanubia, Hungary

Risk drivers are well identified, but the consequences and risks of large-scale implementation of organic crop production are not entirely clear, either locally or globally. In this regard, it has to be considered that farming risks are not shared equitably among all stakeholders and beneficiaries.

Western Finland

Application of CCF in the DISTDYN research areas do not carry risks or negative impacts over to adjacent areas or stakeholders therein. Adversities may emerge with large-scale application of CCF. Lower stem wood yield in CCF is a known trade-off, while unskilled or negligent application of the novel methods is risky to productivity. The emergent and mounting natural calamities due to climate change are similar in CCF and RTF; CCF may contribute by greater resilience but verification for that is lacking. In this regard, there is a lack of knowledge and practical experience of CCF among landowners and professionals.

West Flanders, Belgium

There is an above-average concern for soil health on organic farms, and farmers are well aware of the mitigating effect their soils can have on risks, primarily related to weather, pests, and diseases. However, farmers sometimes have doubts about optimal management practices, such as the depth, type, and intensity of tillage in relation to the technical aspects of crop rotation.

Pampa Region, Argentina

There are works that address risk analysis, with emphasis on the economics, of the implementation of organic agriculture. SENASA also monitors some of these issues in the annual report. There is a lack of studies that address this criterion comprehensively and over time. The lack of budget dedicated to this issue is the main barrier that is hindering a higher alignment with this criterion.

Chiangrai, Thailand

The main large-scale risks and trade-offs have not been identified by producers and researchers. The impacts of stakeholder interests and external ecosystems were also not defined for the risk assessment. The main barrier for achieving a higher score on this criterion is the lack of budget to finance monitoring and dissemination on existing public platforms.

5.2.4. *SSM must address societal challenges that have been identified, thoroughly understood, and well-documented*

Preliminary results included in D3.2 shows that sustainable soil management generally benefits soil functioning, which may have an impact on societal challenges. Results suggest strong benefits of shifting from conventional to organic agriculture in croplands, with little evidence in favour of, or against, similar conversions on forests or grasslands. Sustainable management showed strong benefits for ecosystem functioning. These benefits were particularly pronounced in our cropland sites with generally low initial soil organic carbon.

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

Results indicate that shifting from conventional to organic agriculture will have detrimental effects on crop yield, leaf damage and generally positive effects are expected for soil C, soil nutrients (Nitrogen and Phosphorus), general biological activity (N mineralization and enzymatic activities).

Results of D3.2 also shows that the positive effect of sustainable management generally weakens under drought conditions. In four out of the seven experimental sites (Denmark, Hungary, Ireland, Latvia) we found significant evidence showing that the benefits of sustainable management are more limited under drought conditions.

Latvia

Societal challenges are recognized, but the identification process involves limited input from specific rights holders and beneficiaries. There are still notable knowledge gaps due to insufficient documentation and context-specific information. A more comprehensive research approach is essential to investigate the effects of organic fertilizers and pesticide-free practices on soil biodiversity, soil health indicators, and biodiversity across various trophic levels. It is crucial to conduct comparisons with different farming practices, including conventional methods, reduced tillage, no-till, grazing, and annual versus perennial systems, to assess discernible differences.

Middle Jutland, Denmark

Societal challenges related to the degradation of land, soil, and water are prominent, well-researched, and understood. Using organic nitrogen sources as fertilizers and the omission of pesticides in organic farming addresses these challenges. Organic farmers are well-supported through farmer's organizations and advisory services. However, more research is needed regarding the impacts of organic fertilisers and no pesticides on soil biodiversity, soil health indicators, and biodiversity at other trophic levels.

Region de Murcia, Spain

While concrete policy actions for addressing societal challenges are recognized and being formulated at both global and national levels, it is essential to delve deeper into understanding at a local and regional scale when implementing SSM practices and monitoring soil diversity. In this regard, it is crucial to define an appropriate time scale to comprehend societal challenges in light of emerging events such as economic crises, spikes in oil prices, wars, and political transitions.

Southern Ireland

Societal drivers in grassland systems are well understood and include the necessity to reduce greenhouse gas emissions, decrease nutrient losses to water, increase carbon sequestration, enhance climate resilience, improve soil health, and support low-cost agronomic production. The SSM intervention addresses many of these aspects. However, additional data is needed regarding the soil health benefits.

South Transdanubia, Hungary

The societal challenges are understood, and the drivers and responses to these challenges are mostly identified. However, there are persistent gaps in documentation, impact assessment, and knowledge. It should be noted that the main challenges vary both locally and globally.

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

Western Finland

Biodiversity and habitat loss and degradation as a whole are well understood and documented based on regular surveys and assessments. However, below-ground ecosystems and conditions are far less known and attended to than above-ground ones. In this regard, there is a lack of interest, knowledge and resources for soil-related R&D.

West Flanders, Belgium

Specific societal challenges related with agriculture, such as the reduction of nitrate leaching, erosion and reduction of soil fertility, have been identified at the national level and have been incorporated into legislation. Farmers' organizations are consulted throughout this process. However, the objectives outlined in the implemented legislation are frequently not achieved, primarily due to the high intensity of farming practices combined with changing weather patterns. Consequently, there has been a transition from mutually agreed-upon legislation to government-imposed regulations, often relying on fixed calendar dates. This approach is often perceived as unrealistic and has resulted in resentment among stakeholders.

Pampa Region, Argentina

From the national regulatory framework, organic agriculture is promoted to tackle issues such as land degradation, food security, environmental degradation, and biodiversity loss. This means that at the national level, social challenges are well recognized. However, this SSM may not be aligned with responses to most of the identified social challenges. Currently, in Argentina, the primary destination for organic products is exportation. This implies that the local population either does not consume or lacks easy access to these products due to their high cost. There is a lack of promotion and investment in all areas (research, production, outreach) regarding societal challenges.

Chiangrai, Thailand

5.2.5. *SSM practices have a positive impact on soil biodiversity and ecosystem integrity and the impact is periodically assessed*

Preliminary results included in D3.2 shows that sustainable soil management generally benefits soil functioning, and has more limited effects on soil biota. The results included in D3.2 shows that the different sites harbour a unique soil biodiversity, with the factor site explaining 54-75% of the variance in the data of alpha and beta diversity. Management effects significantly influenced all three groups of the soil biota but explained only around 2% of the variability. However, these management effects were highly site-specific, with the interaction between site and management explaining around 10% of the variability. Fungal and eukaryotic communities seem to be less responsive than prokaryotes to site, management and drought as a whole, while showing effects of specific groups.

Results indicate that shifting from conventional to organic agriculture will have detrimental effects on N-related bacteria and collembola. However, generally positive effects are expected for general biological activity (N mineralization, enzymatic activities), and fungi (including mycorrhizae) communities. There are several neutral or negative effects in faunal and other eukaryotic groups.

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

Latvia

The SSM outcomes related to biodiversity and ecosystem integrity lack specificity. Limited documented measurements exist regarding the effects of organic soil practices on biodiversity, and scalable results are notably scarce.

Middle Jutland, Denmark

There are few documented measurements of the impacts of organic soil practices on biodiversity, nor are there scalable results. The lack of data and research on soil biodiversity, its impact, and the management practices that facilitate its proliferation are significant barriers that impede a higher fulfilment of this criterion.

Region de Murcia, Spain

Some trends have started to be found at the European scale through the biodiversity analysis done in SOILGUARD, however, specificity for each of the regions and countries is lacking. However, with the advancement of European biodiversity monitoring legislation, more appropriate metrics could emerge in the near future. In this regard, there is a need of funding and human resources to deploy an edaphic biodiversity monitoring campaign on an adequate scale.

Southern Ireland

There is still limited information about the biological health of reduced diversity grassland systems, which predominate in intensively managed grassland systems. Farmers are reporting improved structure and enhanced earthworm populations with more diverse swards. Some research is available on individual sites demonstrating soil biodiversity benefits as linked to the change in management. However, a larger scale assessment at the farm, landscape, and national levels is still lacking. Additionally, there is no large-scale monitoring system in place. There is currently insufficient data available on the soil biological status of the SSM at all scales and the available data is limited to certain ecological groups.

South Transdanubia, Hungary

Clear and measurable outcomes for biodiversity conservation are not identified and assessed

Western Finland

Systematic approaches to measure soil biodiversity conservation outcomes and ecosystem integrity are underdeveloped compared to above-ground features, both in the DISTDYN and larger contexts due to lack of interest, knowledge and resources for soil-related R&D.

West Flanders, Belgium

The primary observable outcome is the abundance of earthworms. The significance of earthworms is acknowledged, and farmers assess their abundance, although not systematically. Additionally, general soil assessments, such as aggregate stability, are frequently conducted visually by taking a sample of soil and evaluating the way it crumbles. However, soil biodiversity conservation outcomes are difficult to measure and a monitoring system that goes into detail and that is sufficiently accurate to base

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

management decisions upon is not available, and will probably be way too expensive and time consuming.

Pampa Region, Argentina

There are very few studies addressing biodiversity conservation outcomes of organic agriculture. Additionally, there is no assessment and monitoring system at any scale.

Chiangrai, Thailand

Some trends have begun to emerge at the European scale but, specificity for each region and country is still lacking. With the advancement of Thailand's biodiversity monitoring legislation, more appropriate metrics may emerge in the near future. The main barrier to achieving a higher score in this criterion is the lack of budget and human resources to deploy a soil biodiversity monitoring campaign on an adequate scale.

5.2.6. *SSM practices have a positive impact on human wellbeing and the impact is periodically assessed*

The results presented in D3.2 show that sustainable soil management generally benefits soil functioning, which may have an impact on several beneficiaries and human well-being ultimately. These results suggest strong benefits of shifting from conventional to organic agriculture in croplands, with little evidence in favour of, or against, similar conversions on forests or grasslands. Sustainable management showed strong benefits for ecosystem functioning. These benefits were particularly pronounced in our cropland sites with generally low initial soil organic carbon.

Latvia

General human well-being outcomes and benchmarks identified but no provision has been made for their assessment. There is insufficient research specifically addressing the correlation between soil management and human well-being.

Middle Jutland, Denmark

To the best of our knowledge, human wellbeing is not monitored in relation to organic soil management practices. From the surveys conducted in this project, there is little indication that the human dimension is weighted strongly by farmers even in organic farming systems. Rather, it is production levels and environmental health that are prioritized by farmers. More studies are needed to assess farmers' wellbeing and the nutritional value of food produced using organic soil management practices. In this regard, there is a lack of research focusing on human wellbeing as it is correlated to soil management.

Region de Murcia, Spain

The identification of all beneficiaries is vague and does not have specific monitoring metrics regarding the implementation, appropriation and benefits from the use of the SSM practices. There is a lack of human resources and budget allocation for design and monitoring, especially concerning indicators within the Sustainable Development Goals (SDGs). Additionally, there is uncertainty regarding the

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

continuity of SSM and its long-term impact on human well-being, particularly in the face of political changes.

Southern Ireland

Human well-being outcomes are either unidentified or vaguely defined, lacking benchmarks and provisions for assessment.

South Transdanubia, Hungary

There are no local benchmarks to monitor impacts and human wellbeing outcomes. In this regard it has to be considered that human wellbeing may has different priorities at global and local scale.

Western Finland

Positive impacts on human wellbeing are generally known from basic research but benchmarks, assessments and strategic initiatives are minuscule both in the DISTDYN and larger contexts because there is little political interest as the benefits are difficult to express in monetary terms.

West Flanders, Belgium

There is no evidence to assess how SSM practices have a positive impact on human wellbeing.

Pampa Region, Argentina

Organic agriculture addresses specific challenges while simultaneously providing benefits for human well-being and biodiversity.

Chiangrai, Thailand

The identification of all beneficiaries is vague, and there are no specific monitoring metrics regarding the implementation, adoption, and benefits of SSM practices. The main barrier to achieving a higher score on this criterion is the lack of human resources and budget for design and monitoring (or integration as indicators within the SDGs), as well as the uncertainty of their permanence over time due to political changes.

5.3. Beneficiaries

5.3.1. *The stakeholders and beneficiaries have been identified and governance processes are participatory, inclusive, transparent and empowering*

Latvia

Main stakeholders and beneficiaries are identified, but measures directly affects only farmers. There is an insufficient linkage between researchers, farmers, stakeholders and governance. The main barrier is extending research and disseminating findings to stakeholders.

Middle Jutland, Denmark

There have not been extensive stakeholder analyses conducted that includes all stakeholders involved in organic farming. Additionally, not all direct and indirect stakeholders are involved, nor are they

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

informed about all processes related to organic farming. However, there is strong support and communication regarding the implementation and innovation of organic farming practices and developments. There is also information available for consumers about the benefits of organic farming and food. This has led to a strong public interest in organic food, with 80% of Danes purchasing organic food items every week. There are difficulties to extend research and dissemination activities to all direct and indirect stakeholders.

Region de Murcia, Spain

Some of the main stakeholders have been identified, but there is a lack of links with government institutions that have a list of farmers to be able to call them for consultations or any other participatory process. In this regard, although there is a regional mapping of NGO representatives and agricultural decision-makers, there is a lack of collaboration schemes to be able to broadly extend the information to potential interested farmers.

Southern Ireland

No formal stakeholder analysis has been undertaken, to our knowledge. However, good consultation around the SSM implementation has taken place with farmers and advisors. Further, policy makers and other interested parties have received communication regarding the impact of the SSM intervention, and this has informed the provision of national farming schemes. It is unlikely that there has been much engagement with consumer stakeholders. From the farmer perspective, implementation of the SSM is voluntary and drivers for implementation include economic and environmental benefits.

South Transdanubia, Hungary

All rights holders and beneficiaries are identified, but the measures directly affect only farmers, while the entire society benefits indirectly through interaction. Governance processes are not participatory but are supervised and transparent.

Western Finland

Metsähallitus (a state agency) is the primary beneficiary and stakeholder in the DISTDYN venture. In a wider context, landowners, corporate wood buyers and users are directly involved in governance in forest policies including CCF. Stakeholders that are only indirectly affected remain in the side-lines. Feedback and grievance mechanisms tend to work through unofficial channels and confrontation. The political balance of power as reflected in governance on forestry and ecology is the main barrier to achieve more participatory, inclusive and transparent processes.

West Flanders, Belgium

Rights stakeholders and beneficiaries are identified, and legislation is in place to ensure basic SSM. However, this legislation is sometimes perceived as unfair and too general. Control mechanisms aimed at preventing nitrate leaching are particularly perceived as unfair, as farmers are often fined for the outcomes of processes they do not fully understand or control.

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

Pampa Region, Argentina

Organic producers are mostly identified, as they need to be registered to access their primary market, which is for exportation. There are no records indicating that stakeholders are involved in all intervention processes. Furthermore, the decision-making processes are not documented, and if there is documentation, it lacks accessibility. The only continuous record available is the annual report based on information provided by certifying entities authorized by SENASA (the enforcing authority) with the aim of showcasing the evolution of organic production during the analysed period in comparison to previous ones.

Chiangrai, Thailand

No rights holders and beneficiaries have been identified. There is a lack of connection with government institutions that have lists of farmers, making it difficult to engage them in consultations or other participatory processes. Although there is a regional mapping of NGO representatives and agricultural decision-makers, collaboration schemes are lacking, preventing the broad dissemination of information to potentially interested farmers.

5.3.2. *The rights, usage of and access to land and resources, along with the responsibilities of different stakeholders are acknowledged and respected*

Latvia

Most rights, usage of and access to land and resources, as well as responsibilities were analysed. All those analysed are acknowledged and respected although knowledge gaps persist in some areas or parts of the SSM practices. The primary barriers to achieving a higher score in this criterion are the lack of funding and human resources.

Middle Jutland, Denmark

There has not been a stakeholder mapping analysis including the usage and access to land and resources. Access to land and resources are respected. Farmers practicing organic management receive economic support and the benefits lent to the environment are acknowledged. In this regard, it is difficult to define and conduct a broadscale stakeholder mapping analysis.

Region de Murcia, Spain

To the best of our knowledge, analyses of resource access and use, based on the mapping of decision makers, have not been conducted due to a shortage of human resources for performing the analysis.

Southern Ireland

A stakeholder mapping/analysis has not been completed. From the farmer perspective, implementation of the SSM is voluntary and drivers for implementation include economic and environmental benefits. Usage of land resources are respected.

South Transdanubia, Hungary

The rights, usage of and access to land and resources as well as stakeholder responsibilities are identified, but they are not incorporated into a stakeholder mapping analysis.

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

Western Finland

The rights, usage of and access to land and resources, along with the responsibilities of different stakeholders are very well identified, documented and legislated in the Nordic context. However, timber as an industrial resource has a very high priority, often pushing other considerations into the side-lines. The balance of power, as reflected in governance and timber markets, constitutes the main barrier to achieving a better respect for rights, land and resource usage, and access to land and resources.

West Flanders, Belgium

Rights, usage, and access to land, along with stakeholder responsibilities, are clearly defined. For a farming practice to be labelled as organic, farmers must adhere to a specified set of rules, which are subject to inspection. However, this set of rules does not entirely align with SSM, as certain unsustainable soil management practices are still permitted. While the organic label primarily emphasizes product-related aspects, such as the absence of pesticides and genetically modified organisms, it also aims to promote sustainable soil management. Notably, there are no restrictions imposed on practices like ploughing.

Pampa Region, Argentina

No documents were found that identify the rights, usage, and access to land and resources. While there have been some government initiatives aimed at providing land access to low-income rural families, these initiatives are very specific and limited in scope. In Argentina, there is a significant conflict over land tenure, especially in the northern regions of the country, involving indigenous communities.

Chiangrai, Thailand

Analyses of resource access and use based on the mapping of decision makers have not been carried out due to a lack of human resources.

5.3.3.*SSM practices are economically feasibility*

Sustainable soil management practices play a crucial role in providing economic value through their impact on NCP, particularly in the areas of climate regulation, food and feed production, and soil formation and protection. In SOILGUARD, the valuation of soil-mediated NCPs is based on an integrated valuation framework (see SOILGUARD Deliverable 4.1) in order to account for the diversity of values for human well-being through soil biodiversity (see SOILGUARD Deliverable 1.3, Soil and Biodiversity Framework, SBWF). The elicitation of such values can inform and make visible the benefits of soils as well as aid in addressing the need of policy instruments for improving the update of sustainable soil management practices (Bartkowski et al., 2020, Hanley & Barbier, 2009). The value of NCPs is provided not only in the form of financial value from the perspective of a farmer but also in the form of public goods, which are not traded in markets. Although there may be no price for such public goods, methods such as cost-based valuation approaches allow for the assessment of such values following the implementation of sustainable soil management practices. Cost-based valuation approaches are employed to quantify and assess these contributions, accounting for the instrumental

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

values at the core of the economic valuation perspective and encompassing the total economic value (TEV) given different use and non-use values (Christie et al., 2019, Pascual et al., 2015). Here's an overview of the economic value associated with sustainable soil management practices for three key NCPs:

1. Climate Regulation (reduction of carbon dioxide emissions):
    a. Economic valuation: Sustainable soil management practices, such as conservation tillage and cover cropping, contribute to carbon sequestration in the soil, reducing the release of carbon dioxide into the atmosphere. The valuation involves estimating savings on the economic cost of carbon emissions, often called social costs of carbon. By preventing further emissions of carbon from soils and supporting the retention of soil organic carbon, a contribution to the prevention of the societal damage of climate change can be achieved. This is valued through the social cost of carbon proposed by the German Environment Agency and is valued at 195 €/t of carbon dioxide equivalents (Matthey & Bünger, 2020)
2. Food and feed production (changes in crop productivity and yield):
    a. Crop Productivity and yield: Sustainable soil management practices enhance soil health, leading to improved crop productivity and resilience (Shrestha, 2015). Valuation considers the economic gains from increased yields, which can translate into higher incomes for farmers. By minimizing soil degradation, sustainable soil management practices can reduce costs of production and produce higher benefit-cost ratios for the farmer (Ghimire, 2014). To value such benefits, the difference in total net income from farmers based on the prices of farm products and the production costs before and after the introduction of sustainable soil management practices are compared. As an example, in addition to the numerous valued non-market benefits of organic agriculture over conventional agriculture, Sandhu et al. (2008) calculated the difference of the average economic value of food resources from organic fields of the Canterbury Region in New Zealand to be approximately 770 USD / (ha-yr.) higher than from conventional fields.
3. Soil formation and protection (reduction of fertilizer use and nutrient runoff):
    a. Reduced fertilizer costs: Sustainable soil practices such as switching from conventional to organic farming can promote nutrient cycling and reduce the need for synthetic fertilizers. Valuation involves estimating the cost savings for farmers due to reduced fertilizer inputs through improved nitrogen mineralization and fixation (Fan et al., 2020), which can be estimated through typical market prices of various types of fertilizers.
    b. Prevention of nutrient runoff and leaching: Sustainable practices such as cover crops and conservation tillage contribute to soil structure improvement, reducing the risk of nutrient and sediment runoff into water bodies (Hobbs et al., 2008). This helps avoid the costs associated with water treatment, eutrophication, and the negative impacts on aquatic ecosystems. For example, Zakeri et al. (2020) estimated the contribution of vegetation cover to soil conservation in northeastern Iran to have an economic value of 55,335 USD / (ha-yr.) based on the income values of rainfed wheat cultivation, and the authors also estimated the economic value of reduced erosion and sediment transport to be over 5 million USD / yr. based on removal costs of sediment with gabion structures and sediment removal ponds. Furthermore, combined food and energy systems such as agroforestry can increase the supply of economic value of non-marketed NCPs when compared to conventional monocultures. Ghaley et al. (2015) demonstrated the

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

economic value of combined food and energy supply systems to be 461 USD / (ha-yr.) higher than for conventional monocultures.

In summary, the economic value of sustainable soil management practices is derived from the cost savings and societal benefits associated with mitigating climate change, improving crop productivity, and protecting soil and water resources. In this regard, although shifting from conventional to organic agriculture, may result in higher costs for the farmer (on a private business level) due to lower crop productivity, society benefits from such management changes. In this regard, the lack of data is one of the main barriers to value the SSM practices.

Latvia

The examination of costs and benefits encompasses both financial and non-financial dimensions, yet there exist gaps, particularly in grasping indirect costs and benefits. The analysis is limited to the SSM site and/or specific aspects of the SSM lifecycle, lacking a comprehensive and verified understanding of the overall distribution of major costs and benefits.

Middle Jutland, Denmark

The indirect costs and benefits associated with organic soil management have not been assessed on a large scale, and there is not comprehensive documentation of the indirect costs and benefits associated with organic farming, to our knowledge. It is unclear how the cost-effectiveness of organic farming fits into the Danish food system and if there has been in-depth analysis to justify it. However, farmers do receive subsidies and support to farm organically because it is well-acknowledged that yields are typically not as high in organic production, but the benefits to the environment are worthwhile and therefore incentivised by policies.

Region de Murcia, Spain

There is a general notion of the cost-benefits of SSM practices, but specific studies are needed to assess gross and net costs considering European and national subsidies.

Southern Ireland

Some analysis of costs and benefits has been undertaken but a comprehensive understanding of indirect costs and benefits is not available. Implementation of the SSM is cost-neutral and may in fact save money to the farmer in fertiliser costs. No evidence is found about a formal analysis of costs and benefits.

South Transdanubia, Hungary

Direct and indirect benefits and costs associated with the SSM practice are identified, but economical viability heavily depends on the specific environmental and economical conditions, so a long-term analysis is needed including future scenarios.

Western Finland

Accumulation of data and subsequent analysis of the economic consequences of increased CCF is one of the primary targets of the DISTDYN project. On a larger scale, this is considered one of the key areas of R & D around CCF in the Nordic area. The main components and approaches are known and under

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

scrutiny, but the research and knowledge bases are still narrow. In this context, it must be acknowledged that forest research is a time-consuming activity, particularly the process of collecting empirical data and evidence. Moreover, political and economic aspirations often pose challenges in establishing common ground for analyses and conclusions.

West Flanders, Belgium

There are significant gaps in understanding the direct and indirect benefits of SSM. The costs of SSM are reasonably well known, except perhaps for fuel costs, but the impact on crop yield is challenging to decipher, and often the effect is cumulative over the years. The effects of indirect costs and benefits (e.g., pests and diseases) are often recognized but not quantified. The primary obstacle to achieving strong economically feasibility is the extreme complexity of obtaining reliable data to quantify the indirect costs and benefits of SSM.

Pampa Region, Argentina

No report was found that analyses the costs and benefits related to trade-offs. A meaningful review of the proposed intervention's cost-effectiveness against other viable alternatives was also not found. There is no clear understanding or guarantee of the main funding source required to cover the piloting phase. Additionally, there has been no analysis of potential future or complementary revenue options. As mentioned in the previous criterion, there is a lack of political commitment to promote this practice and insufficient resources dedicated to researching these topics.

Chiangrai, Thailand

5.4. Responses

5.4.1. *Lessons learned are documented and shared*

Latvia

Lessons learnt have been systematically captured and some shared in an accessible manner but communications strategy is incomplete.

Middle Jutland, Denmark

There is sharing of knowledge from research findings and from trials conducted at the commercial level. There are frequently workshops and webinars available to farmers and the general public. However, there is not a clear detailed strategy about how these communications will change behaviours and trigger transformational change. In this regard, the continuous communication between research, consultants, advisors, and farmers on findings from trials can be a slow process and therefore is not always up to date.

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

Region de Murcia, Spain

While there are communication strategies for various audiences and some lessons learned from the literature and the work of the SOILGUARD project have been documented, they are insufficient for scaling up biodiversity indicators to a regional level in the study.

Southern Ireland

Knowledge from research findings are continually translated into practical and accessible farmer advice that will impact implementation and adoption of the intervention. In Teagasc, this is achieved through a dedicated extension and advisory service and communication channels have been optimised. In this regard, new research needs to be continually communicated.

South Transdanubia, Hungary

Both economic and ecological aspects of organic crop production are published in many scientific and popular science paper, but the details of organic crop production are highly context-specific, so studies should be conducted under various site and market conditions.

Western Finland

Capture, documentation and sharing are systematically and strategically pursued in the DISTDYN and METSO contexts. On a larger scale regarding CCF, there is no communication strategy and the tasks are pursued individually by agencies and stakeholders.

West Flanders, Belgium

Experiences with SSM are often shared and discussed among farmers in a non-organized manner. There are initiatives to facilitate peer-to-peer learning, as well as government and commercial initiatives to support knowledge transfer within organic farming. However, it is often challenging to identify the best management strategies, as strategies should be context-specific.

Pampa Region, Argentina

The lessons learned are shared in closed environments such as groups of producers or in the academic field, a communication strategy was not found. In this regard, the main barrier hindering a stronger alignment with this criterion is the lack of resources.

Chiangrai, Thailand

There is a general understanding of the cost-benefits of SSM practices, but specific studies are needed to assess gross and net costs, taking into account national subsidies. The main barrier to achieving greater economic viability is the lack of human resources to perform the analysis.

5.4.2.*SSM practices are managed adaptively, based on iterative learning*

Latvia

Typically, learning occurs as farmers share experiences at field workshops or events, and through the outcomes of localized research trials. However, there is currently no comprehensive learning and

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

monitoring plan in place at a scaled level and dissemination of organic farming knowledge has not been prioritized at the national level.

Middle Jutland, Denmark

Learning is typically done through farmers sharing experiences at workshops or events, or through the findings of localized research trials. However, there is not a scaled learning and monitoring plan in place and a program to monitor, evaluate, and disseminate findings related to organic soil management is not prioritized across the national scale.

Region de Murcia, Spain

There is currently no adaptation and evaluation plan in place. Additionally, the plots analysed have conversion times that are too short to observe clear changes in the multi-functionality of the soil. WP1 is in the process of developing a framework for disseminating experiences, which will include the identification of general patterns within the project.

Southern Ireland

There is no formal learning framework, however, research learnings are continually translated into farmer advice and through trial and error farmers are modifying their practice to suit their local conditions. Peer to peer learning as facilitated by open days and farmer discussion groups is ongoing. There is no formal monitoring of the SSM and knowledge is gleamed from farmer experience and sporadic research experiments.

South Transdanubia, Hungary

There is no learning framework applied to the SSM practices for iterative learning throughout the intervention lifecycle. The framework for SSM is the criteria for organic crop production.

Western Finland

Adaptive management is one of the key features in the DISTDYN venture, including systematic monitoring, analysis, feedback, and response mechanisms to CCF activities. On a larger (national) scale, such mechanisms are dispersed among governance and stakeholders with no strategic approach. The main barriers for the implementation of adaptative management is the adherence to decades-old simplistic solutions, the prioritization of economic stability and the existing balance of power.

West Flanders, Belgium

Mostly, farmers learn from their own experiences and adapt accordingly. Many learning frameworks are temporary and based on governmental and commercial initiatives. These sometimes result in more permanent informal learning groups, often using platforms like WhatsApp. There are organizations in place that provide ongoing assistance and training, but they do not reach all farmers. Mutually agreed trade-offs are respected in most cases and linked to governmental controls, covering aspects such as soil residual nitrogen in autumn, organic carbon, and the risk of erosion.

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

Pampa Region, Argentina

The recorded experiences that share a learning framework are very specific and limited. In this regard, the number of organic farmers is very low compared to conventional ones; perhaps as this group grows, more experiences can be shared.

Chiangrai, Thailand

There is no systematic data collection or dissemination of learning due to a lack of human and financial resources.

5.4.3. *A monitoring and evaluation plan is implemented to assess unintended adverse consequences on nature and review the established safeguards.*

Latvia

A monitoring and evaluation plan are in place but the monitoring does not follow a regular basis due to a lack of funding and human resources.

Middle Jutland, Denmark

Monitoring of organic farming is carried out by research and trials at commercial farms. Also, every organic producer is inspected by the Danish Agricultural Agency, a government body, every year. However, there is no specific strategy precisely stating the economic, social, and environmental outcomes of organic farming across a larger scale. The primary barrier hindering the implementation of a monitoring and evaluation plan is the expense and coordination challenges associated with conducting large-scale research on the unintended consequences of organic soil management across diverse habitats and land use systems.

Region de Murcia, Spain

There is no robust adaptation and evaluation plan or development. The time scale of the organic management type is insufficient and there are no elaborated strategies on whether and how the study assumptions change.

Southern Ireland

Monitoring is conducted only through ad hoc research. However, the impact on the environment has been assessed including on air and water quality. Nature benefits have been observed with SSM implementation but impacts on soil biodiversity require further evaluation. In this regard, further assessment of impacts on soil biodiversity are needed but so far assessments indicate positive benefits of SSM on nature.

South Transdanubia, Hungary

No monitoring and evaluation plan in place. There is a lack of budget allocation for this purpose.

Western Finland

Monitoring and evaluation are systematically pursued, and corrective actions implemented in the DISTDYN venture, but restricted to forest stand dynamics and productivity, with less attention to

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

ecological and other aspects. In the broader (national) context, monitoring and evaluation efforts lack coordination, and there is not a systematic framework. This criterion is not highly achieved, primarily due to fragmented administrative structures related to ecological issues.

West Flanders, Belgium

There is a monitoring plan in place. The government oversees all farmers, including those practicing organic farming, on certain critical parameters (such as soil nitrate in autumn, soil P content, manure production and application, TOC, erosion, among others). Specifically, there is a self-control system for organic farms. The use of pesticides, fertilizers, and crop rotation is documented, which is a prerequisite for obtaining the 'organic' label and can be subject to inspection. However, government controls are perceived as very intrusive, often not taking into account the financial consequences for farmers. The support base for these controls is limited.

Pampa Region, Argentina

No monitoring and evaluation plan was found at a national or regional scale to evaluate unintended adverse consequences on nature and review established safeguards. Lack of resources and incentives are the main barriers that are hindering a higher alignment with this criterion.

Chiangrai, Thailand

There is no adaptation and evaluation plan due to a lack of human and financial resources., in addition to the fact that the plots analysed have conversion times that are too short to see clear changes in the multi-functionality of the soil. A framework for dissemination of experiences is being developed by Soilguard, which will have general patterns identified within the project.

5.4.4. *Relevant policies, regulation frameworks and national and global targets are identified and considered in the SSM practices design*

Latvia

The policy, laws and regulations relevant to the SSM system were identified and considered as part of the design of the SSM system. However, there are gaps in institutional cooperation frameworks with citizen, agrarian, and rural councils.

Middle Jutland, Denmark

Main policies with direct impact on organic farming are considered and policymakers have decided on national targets for climate change, but it is unknown if there are similar targets in place for human wellbeing and biodiversity. There is no clear roadmap in place that details how policies should support organic soil management and farming to be scaled up and how it would address the global and national targets. This is caused by the difficulty to assess and quantify biodiversity and human well-being outcomes t a large scale.

Region de Murcia, Spain

Policies and frameworks such as the SDGs applicable at the European level have been identified, and there are also proposals for regulations to improve the monitoring of soil health and biodiversity.

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

Southern Ireland

Policy and regulations regarding mitigation of greenhouse gas emissions, reduction of fertiliser applications, water quality, and efforts towards carbon neutrality are relevant to the SSM.

South Transdanubia, Hungary

European and National strategies, policies, laws, regulations and rules relevant for organic agriculture and SSM are clear, well defined, identified and taken into account.

Western Finland

Progress regarding policies, regulations and laws around CCF has been tremendous during the 2000s, and continuous revision processes are in place or launched as required. There is strong feedback to and from R&D around CCF. However, targets are not always easily agreed upon by stakeholder segments and governance.

West Flanders, Belgium

Regulations are relevant to SSM, although in most cases, they may not explicitly address SSM. The regulations often focus on broader goals such as water quality, erosion reduction, greenhouse gas emission reduction, and the reduction of ammonia depositions on nearby Natura 2000 areas. However, these overarching goals are also inherently beneficial for SSM. Organic farming regulations are considered in the management.

Pampa Region, Argentina

The law that regulates organic agriculture and the strategic plan identify national and global objectives to achieve human well-being. There are still knowledge gaps, and no connection or plan was formulated in relation to them. In this regard, although the strategic plan is very complete, no records of specific actions for its implementation were found.

Chiangrai, Thailand

Some policies, regulations, and laws relevant to the intervention have been identified. To achieve a higher score in this criterion, lobbying efforts are needed to ensure the successful implementation of these new regulations.

5.4.5. *SSM practices inform and enhance facilitating policy and regulation frameworks and contribute to national and global targets*

Latvia

Relevant national and global targets for human wellbeing, climate change and biodiversity have been also identified. However, assessing and quantifying the impact of soil management practices on biodiversity and human well-being at a large scale pose significant challenges.

Middle Jutland, Denmark

Because there is evidence that organic farming supports the directives associated with climate change and pollutants to soil and water systems, policies support organic farmers economically with subsides.

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

However, fluid and frequent communication on the outcome of different research amongst all stakeholders to influence and change policy is a slow and complex process.

Region de Murcia, Spain

Although there are major frameworks for action such as the SDGs and agricultural incentives such as those of the CAP, these lack comprehensive monitoring of effectiveness at the hands of cereal farmers.

Southern Ireland

Policies, regulations and targets regarding mitigation of greenhouse gas emissions, reduction of fertiliser applications, water quality, and efforts towards carbon neutrality are relevant to the SSM. The SSM also has relevance to the EU Biodiversity 2030 Strategy and the proposed Soil Health Law.

South Transdanubia, Hungary

The intervention action supports facilitating policy and regulation frameworks. The potential contribution of the SSM to relevant national, European and global targets was identified, but was not reported in the relevant platforms yet or just partly

Western Finland

This is one of the main purposes and activities of the DISTDYN project within the METSO framework and beyond. Such activities are regularly pursued according to a strategic plan, involving governance and stakeholders.

West Flanders, Belgium

The Department of Agriculture has 'field officers' who are aware of the current situation on organic farms, and policy is developed through consultation with organic farmer organizations. Certain regulatory frameworks are implemented without much discussion due to high European pressure to achieve specific goals, particularly regarding nitrate leaching into soil and surface waters, where tension is notably high.

Pampa Region, Argentina

Although some pertinent policies, regulations, or laws were recognized, there are still knowledge gaps. The potential contribution to certain national and global targets related to human well-being, climate change, and biodiversity was only partially identified and not reported on relevant platforms. In this regard, the intervention actions and communications are not systematized and well-informed.

Chiangrai, Thailand

Although there are major frameworks for action, such as the SDGs and agricultural incentives, they lack comprehensive monitoring of effectiveness among cereal farmers due to the absence of institutional cooperation frameworks with citizens, Subdistrict Administrative Organizations, and rural councils.

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

6. References

Bartkowski, B., Bartke, S., Helming, K., Paul, C., Techen, A.-K., & Hansjürgens, B. (2020). Potential of the economic valuation of soil-based ecosystem services to inform sustainable soil management and policy. *PeerJ*, *8*, e8749. https://doi.org/10.7717/peerj.8749

Christie, M., Martín-López, B., Church, A., Siwicka, E., Szymonczyk, P., & Mena Sauterel, J. (2019). Understanding the diversity of values of "Nature's contributions to people": Insights from the IPBES Assessment of Europe and Central Asia. *Sustainability Science*, *14*(5), 1267-1282. https://doi.org/10.1007/s11625-019-00716-6

Cohen-Shacham, E., Andrade, A., Dalton, J., Dudley, N., Jones, M., Kumar, C., Maginnis, S., Maynard, S., Nelson, C. R., Renaud, F. G., Welling, R., & Walters, G. (2019). Core principles for successfully implementing and upscaling Nature-based Solutions. *Environmental Science & Policy*, *98*, 20-29. https://doi.org/10.1016/j.envsci.2019.04.014

Cohen-Shacham, E., Walters, G., Janzen, C., & Maginnis, S. (Eds.). (2016). *Nature-based solutions to address global societal challenges*. IUCN International Union for Conservation of Nature. https://doi.org/10.2305/IUCN.CH.2016.13.en

European Commission. (2015). *Towards an EU Research and Innovation Policy Agenda for Nature-Based Solutions & re-Naturing Cities—Final Report of the Horizon2020 Expert Group on Nature-Based Solutions and Re-Naturing Cities*. Publications Office of the European Union: Luxembourg.

European Commission. (2017). *Horizon 2020 Work Programme 2016–2017—12. Climate Action, Environment, Resource Efficiency and Raw Materials*. EC: Brussels, Belgium,.

European Commission. (2020). *Nature-Based Solutions: State of the Art in EU-funded Projects*. Publications Office of the European Union, Luxembourg.

Fan, Y., Liu, Y., DeLaune, P. B., Mubvumba, P., Park, S. C., & Bevers, S. J. (2020). Economic analysis of adopting no-till and cover crops in irrigated cotton production under risk. *Agronomy Journal*, *112*(1), 395-405. https://doi.org/10.1002/agj2.20005

Ghaley, B. B., Sandhu, H. S., & Porter, J. R. (2015). Relationship between C:N/C:O Stoichiometry and Ecosystem Services in Managed Production Systems. *PLOS ONE*, *10*(4), e0123869. https://doi.org/10.1371/journal.pone.0123869

Ghimire, B. (2014). Production Economics of Sustainable Soil Management Based Cauliflower (Brassica Oleracea L. Var. Botrytis) in Dhading District of Nepal. *American Journal of Agriculture and Forestry*, *2*(4), 199. https://doi.org/10.11648/j.ajaf.20140204.23

Hanley, N., & Barbier, E. (2009). *Pricing nature: Cost-benefit analysis and environmental policy. Edward Elgar Publishing.*

Hobbs, P. R., Sayre, K., & Gupta, R. (2008). The role of conservation agriculture in sustainable agriculture. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *363*(1491), 543-555. https://doi.org/10.1098/rstb.2007.2169

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

IUCN. (2020a). *Global Standard for Nature-based Solutions: A user-friendly framework for the verification, design and scaling up of NbS: first edition*. IUCN, International Union for Conservation of Nature. https://doi.org/10.2305/IUCN.CH.2020.08.en

IUCN. (2020b). *Guidance for using the IUCN Global Standard for Nature-based Solutions: First editions* (1.ª ed.). IUCN, International Union for Conservation of Nature. https://doi.org/10.2305/IUCN.CH.2020.09.en

IUCN. (2021). *Planning and delivering Nature-based Solutions in Mediterranean cities. First assessment of the IUCN NbS Global Standard in Mediterranean urban areas.* Málaga, Spain: IUCN. https://www.iucn.org/regions/mediterranean/resources/thematic-documents

Koivula, M., Kuuluvainen, T., Hallman, E., Kouki, J., Siitonen, J., & Valkonen, S. (2014). Forest management inspired by natural disturbance dynamics (DISTDYN) – a long-term research and development project in Finland. *Scandinavian Journal of Forest Research*, *29*(6), 579-592. https://doi.org/10.1080/02827581.2014.938110

Maes, J., & Jacobs, S. (2015). Nature-Based Solutions for Europe's Sustainable Development: Europe's sustainable development. *Conservation Letters*, *10*(1), 121-124. https://doi.org/10.1111/conl.12216

Matthey, A., & Bünger, B. (2020). *Methodological Convention 3.1 for the Assessment of Environmental Costs: Value Factors. Version 12/2020.* Dessau-Roßlau: German Environment Agency.

Pascual, U., Termansen, M., Hedlund, K., Brussaard, L., Faber, J. H., Foudi, S., Lemanceau, P., & Jørgensen, S. L. (2015). On the value of soil biodiversity and ecosystem services. *Ecosystem Services*, *15*, 11-18. https://doi.org/10.1016/j.ecoser.2015.06.002

Shrestha, S. K. (2015). Sustainable soil management practices: A key to combat soil desertification in the hills of Nepal. *World Journal of Science, Technology and Sustainable Development*, *12*(1), 13-24. https://doi.org/10.1108/WJSTSD-07-2014-0015

Zakeri, E., Mousavi, S. A., & Karimzadeh, H. (2020). Scenario-based modelling of soil conservation function by rangeland vegetation cover in northeastern Iran. *Environmental Earth Sciences*, *79*(5), 107. https://doi.org/10.1007/s12665-020-8846-3

7. Appendix A. Description of the assessment tool

This appendix describes the assessment tool used in the procedure outlined in Section 6. The tool has been developed to facilitate the application of the IUCN Global Standard for NbS in actions related to soil management, soil biodiversity, soil multifunctionality, nature's contributions to people, and well-being. To conduct a specific NbS assessment, the Self-Assessment Tool for IUCN Global Standard for NbS should be employed.

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

7.1. Criteria related with influences and drivers

7.1.1. *SSM practices respond to the current state of the ecosystems and soil biodiversity*

Description of the criterion

SSM interventions must be based on a proper understanding of the initial state of soil biodiversity and should be founded upon a clear comprehension of the current status of the ecosystems concerned. The current condition of Natural Capital Assets needs to be assessed and characterized in terms of ecological state. This involves identifying drivers of ecosystem degradation and loss, as well as opportunities to enhance ecosystem integrity and connectivity. Both local and scientific knowledge should be utilized for this purpose. The assessment should take into account 1) attributes of soils and ecosystems that are crucial for delivering NCP, including extent, stock, structure, and condition, and 2) the functions or processes occurring within soils that support NCP. The assessment should be conducted at four different scales: the field scale (e.g., soils), the farm/exploitation scale (e.g., domestic and wild species diversity), the territory or landscape scale (e.g., connectivity), and the regional or national scale (e.g., pollution, land use change, etc.). Figure 11 describes the elements and links considered in the assessment of this criterion.

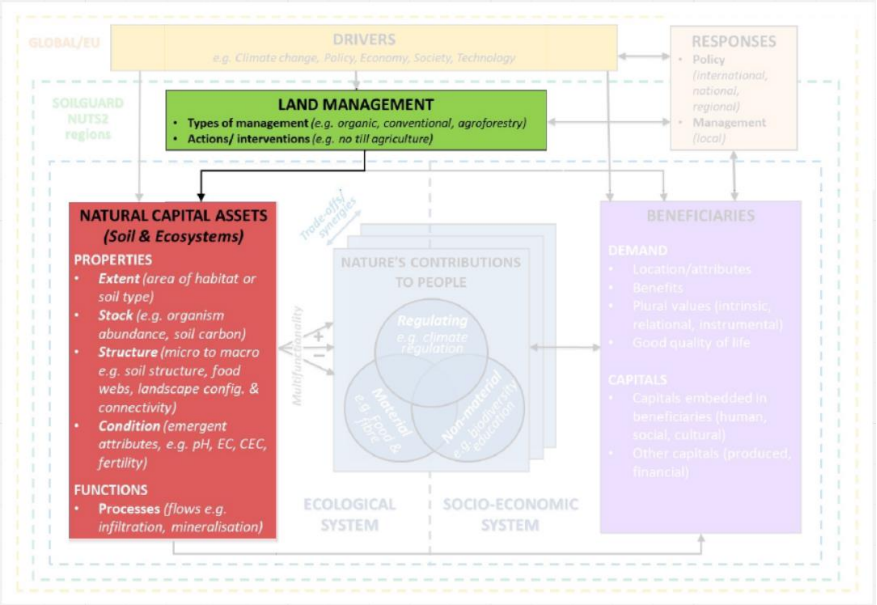


Figure 11. Elements and links from the SBWF considered in the assessment of the criterion: SSM practices respond to the current state of the ecosystems and soil biodiversity

Guiding questions

Has been the current state of the ecological systems assessed? Is this assessment conducted at the appropriate spatial scale? Have the drivers of ecosystem degradation and biodiversity loss been assessed? Does the assessment include field verification? Is both scientific and local knowledge taken into account? Have the requirements to maintain or recover ecosystem integrity been identified? Have opportunities to enhance ecosystem connectivity and integrity been assessed? Do SSM practices

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

respond to the assessment and the identified drivers of ecosystem degradation and biodiversity loss, as well as the opportunities to maintain or recover ecosystem integrity and connectivity?

Score description

Strong	Adequate	Partial	Insufficient
Yes. An updated assessment of the current status of ecosystems at the appropriate spatial and temporal scales is in place. The assessment includes information about the drivers of change and biodiversity loss and a detailed identification of requirements to maintain or recover ecosystem integrity. Options to enhance the integrity of the ecosystem or connectivity are identified.	Information about the current state of ecosystems is available. This information has been generally validated through field visits and input from local knowledge. There is a broad identification of potential options to enhance ecosystem integrity and connectivity, as needed, and a plan to incorporate them into the SSM strategy.	General information about existing land cover and land use is used for assessing the status of the ecosystems. There is not validation at field level and data coming from local communities or traditional knowledge. There is a general identification of potential actions to enhance ecosystem integrity or connectivity.	No. There is no information available about general conditions of the status of the ecosystems at any relevant spatial or temporal scale and there is no identification of any options to enhance ecosystem integrity or connectivity.

7.1.2. *SMM practices recognises and responds to the interactions between the economy, society and ecosystems and integrate complementary interventions*

Description of the criterion

Analysing the environmental, social, and environmental aspects at different scales facilitates the successful implementation of SSM and avoids unexpected damages. Interactions between people, the economy, and the ecosystem should be understood at a landscape level, beyond the limits of the site where the SSM will be implemented, to be considered in the design of the intervention. SSM practices can complement interventions at various scales, establishing synergies across sectors based on specific contexts. This could involve areas such as larger-scale nature restoration initiatives, commercialization and labelling strategies or linkages to specific social tendencies. Such complementary actions will inherently require the identification of synergies across different sectors according to the specifics and context of each situation. Figure 12 describes the elements and links considered in the assessment of this criterion.

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

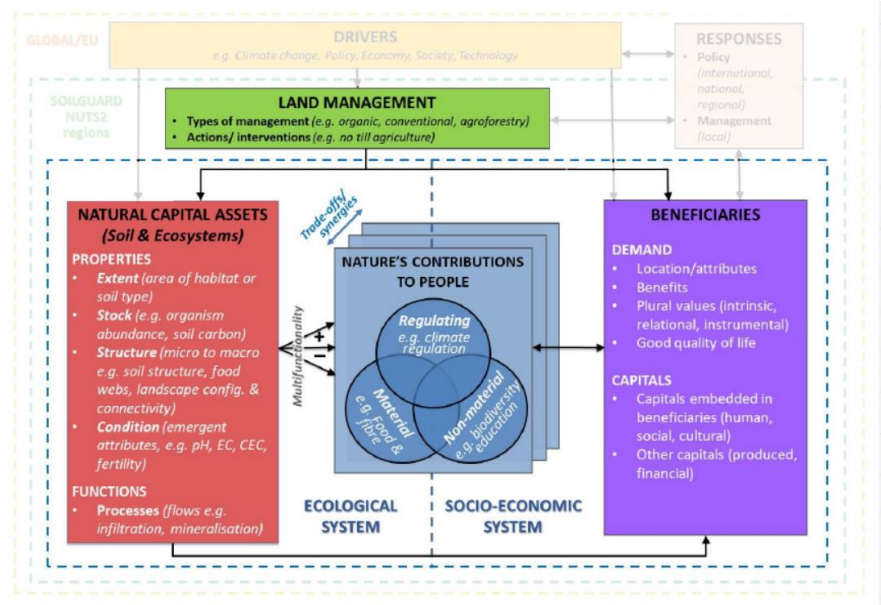


Figure 12. Elements and links from the SBWF considered in the assessment of the criterion: SMM practices recognises and responds to the interactions between the economy, society and ecosystems and integrate complementary interventions

Guiding questions

Are interactions between the economy, society and ecosystems identified? Does those include those within and surrounding the intervention area? Is the change in these interactions considered over time? Are these interactions used to design the intervention and decision-making processes? Are complementary interventions identified in and around the area? Are SSM practices integrated with relevant complementary interventions? Are synergies sought in project management, monitoring and outcomes? Are complementary interventions and synergies re-assessed throughout the intervention time frame

Score description

Strong	Adequate	Partial	Insufficient
Yes. SSM practices considers in detail the interactions between the economy, society and ecosystems within and surrounding the intervention area. Synergies across sectors are thoroughly investigated, and all relevant complementary interventions are integrated within SSM practices. These interactions, complementary interactions and synergies are accounted, investigated and revisited for in the decision-making process throughout the intervention timescale.	SSM practices respond to specific interactions between the economy, society and ecosystems, and synergies across sectors are investigated and the most relevant complementary interventions are integrated within the SSM practices. These interactions, complementary interactions and synergies are accounted at least once during the intervention period.	SSM practices respond to some of interactions between the economy, society and ecosystems. Synergies across some sectors are broadly identified. Knowledge gaps persist. Interactions are partially or not at all accounted for in decision-making processes and only some complementary interventions are integrated into SSM practices.	No. SSM practices does not recognise nor respond to the interactions between the economy, society and ecosystems. Synergies across sectors are not identified, and if any complementary interventions are identified, they are not integrated into SSM practices.

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

7.1.3. *Risks and trade-offs are identified, managed, and inform corrective actions and safeguards*

Description of the criterion

Soil management has the potential to either positively or negatively impact, or be impacted by, stakeholders, interests and ecosystems outside the immediate intervention area. Such types of interactions both within and around the intervention area need to be understood and accounted for in the decision-making processes. The intervention should include risk management options to minimize the potential adverse impacts that could undermine the ecological foundations of the solution. Risk management should be particularly emphasized during the transition period from established practices to proposed new practices. Trade-offs should be identified, and safeguards defined to prevent adverse consequences and ensure that mutually-agreed limits are defined to ensure the stability of the management system. Figure 13 describes the elements and links considered in the assessment of this criterion.

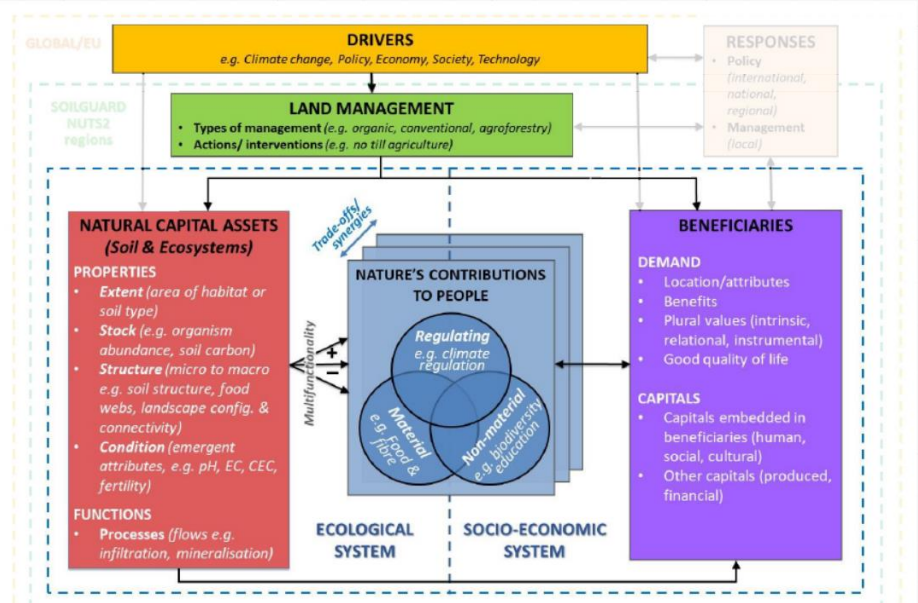


Figure 13. Elements and links from the SBWF considered in the assessment of the criterion: Risks and trade-offs are identified, managed, and inform corrective actions and safeguards

Guiding questions

Have the drivers of internal and external risks been identified? Has scientific and local knowledge concerning those risks been taken into account? Does the design of the SSM system take into account possible internal and external risks? Has a risk management plan been integrated into the design of the SSM system? Will this risk management plan be revisited throughout the intervention time scale? The design includes the identification of trade-offs and the design of safeguards, corrective actions and risk mitigation measures? Are there mutually agreed upon limits of trade-offs?

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

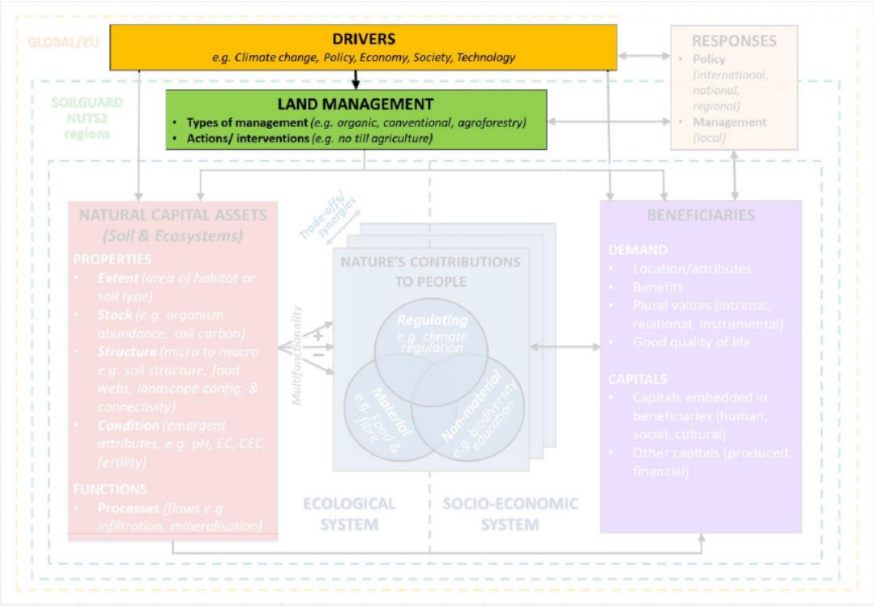
Score description

Strong	Adequate	Partial	Insufficient
Yes. The possible risks of undesirable changes and their drivers are identified, taking into account scientific and local knowledge. The management of these risks is integrated into the design of the SSM and revisited throughout the intervention time scale. Possible adverse impacts of SSM interventions on ecosystems, ecological process and species identified. Mutually agreed upon limits of trade-offs are in place and documented. Safeguards are in place, with clear documentation of this being provided.	Most risks of undesirable changes and their drivers are identified, taking into account scientific and local knowledge. The management of most of these risks is integrated into SSM practices and revisited at least once during the intervention time scale. Possible adverse impacts of SSM practices on ecosystems, ecological process and species have been identified. Mutually agreed upon limits of some trade-offs are in place. Safeguards are in place with some documentation provided	Some possible risks are identified and taken into account in the design of the SSM practices, but context-specific knowledge gaps persist and multiple documentation (e.g. their management, within the intervention site and across the broader land/seascape) are lacking. There is a general identification of possible negative impacts of SSM practices actions at ecosystem level. Mutually agreed upon limits of only a few trade-offs are in place. Few safeguards are in place and there is no documentation of the process	No. Limited or no risks are identified and, where identified, the management of these are not integrated into the design of the SSM practices. There is no identification of potential impacts of SSM practices. Mutually agreed upon limits of trade-offs have not been considered and no safeguards have therefore been put in place.

7.1.4. *SSM must address societal challenges that have been identified, thoroughly understood, and well-documented*

Description of the criterion

SSM practices must address societal challenges, such as food security, biodiversity loss and environmental and land degradation. The societal challenges that are addressed should be clearly understood and documented. The identification of the challenges to be addressed should be used as an opportunity to increase the knowledge and awareness of communities and stakeholders. Figure 14 describes the elements and links considered in the assessment of this criterion.



The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

Figure 14. Elements and links from the SBWF considered in the assessment of the criterion: SSM must address societal challenges that have been identified, thoroughly understood, and well-documented

Guiding questions

Are the societal challenges understood at the relevant context? Are the societal challenges documented and accessible to affected stakeholders? Are the drivers and responses to the societal challenges identified? Are SSM practices aligned with the responses to the societal challenges identified?

Score description

Strong	Adequate	Partial	Insufficient
Yes. The most pressing societal challenges are prioritized based on full consultation with rights holders and beneficiaries. The drivers of and responses to identified societal challenges are well understood, including with reference to the relevant national/local context, and are fully documented and accessible.	Specific societal challenges are identified with some consultation with rights holders and beneficiaries. Drivers of and responses to identified societal challenges are broadly understood within the relevant context although some documentation and knowledge gaps persist.	General societal challenges are identified with limited input from some rights holders and beneficiaries only. Societal challenges framed in terms consistent with widely accepted narratives but multiple documentation and context-specific knowledge gaps persist.	No. No clear societal challenges are identified and/or no consultation with any rights holders and beneficiaries. Superficial/limited understanding of drivers of and responses to identified societal challenges with limited or no documentation.

7.1.5. *SSM practices have a positive impact on soil biodiversity and ecosystem integrity and the impact is periodically assessed*

Description of the criterion

Clear and measurable biodiversity conservation outcomes must be identified, benchmarked and periodically assessed. SSM practices have several impacts on the ecosystems and interact with the territory beyond the intervention area. Therefore, it is essential to monitor and assess the positive impact of SSM on key biodiversity values and ecosystems. In order to inform the design, monitoring and assessment of SSM, targets for enhancing key biodiversity values should be established. SSM could have impacts on 1) attributes of soils and ecosystems that are important for delivering NCP: extent, stock, structure, condition and 2) functions or processes that occur within soils supporting NCP. Figure 15 describes the elements and links considered in the assessment of this criterion.

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

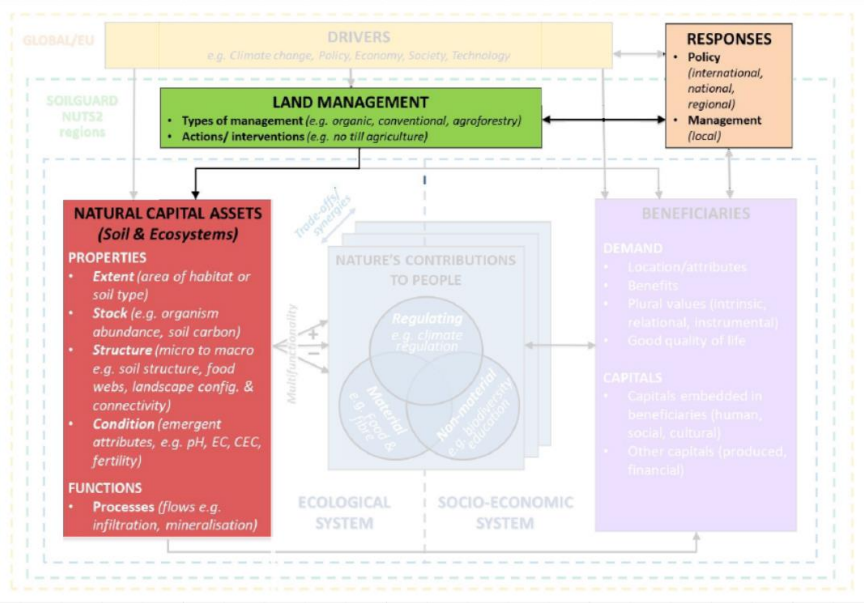


Figure 15. Elements and links from the SBWF considered in the assessment of the criterion: SSM practices have a positive impact on soil biodiversity and ecosystem integrity and the impact is periodically assessed

Guiding questions

Are clear and measurable biodiversity conservation outcomes identified? Are these outcomes based on an understanding of the current ecosystem state? Are the conservation outcomes periodically assessed?

Score description

Strong	Adequate	Partial	Insufficient
Yes. A monitoring system is in place. This includes the specific variables to be assessed related to soil biodiversity and ecosystem integrity, the frequency of assessment, the analyses that will be done to determine outcomes, and how information will be shared. Monitoring provides enough information to indicate species or ecosystem recovery and potential adverse impacts. A baseline assessment of the indicator variables has been conducted considering the monitoring criteria.	A monitoring system is in place. This includes the specific variables to be assessed related to biodiversity and ecosystem integrity, but may lack specific details on the frequency of assessment, the analyses that will be done to determine outcomes, or how information will be shared. A baseline assessment has been conducted, but also lack specific details. There is not enough information on ecosystem indicators for a relevant period of time. A monitoring plan for assessing adverse impacts is under development.	The SSM outcomes related to biodiversity and ecosystem integrity lack specificity. There is a general indication about relevant conservation outcomes and a monitoring system is under preparation.	No, there are no identified outcomes related to biodiversity or ecosystem integrity. There is no monitoring system in place, and no data is available about ecosystem, impacts on nature or species recovery.

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

7.1.6. *SSM practices have a positive impact on human wellbeing and the impact is periodically assessed*

Description of the criterion

SSM must address specific challenges while simultaneously providing human well-being and biodiversity benefits. It should preserve and enhance soil biodiversity and increase the flow of ecosystem services through activities that promote job creation, empowering women and vulnerable groups or ensuring yields to meet the needs of the population. Specific, measurable, attainable, realistic and timely (SMART) targets should be used for accountability and informing adaptive management. The SSM strategy should define the intended outcomes and provide a clear understanding of how these should be achieved. Figure 16 describes the elements and links considered in the assessment of this criterion.

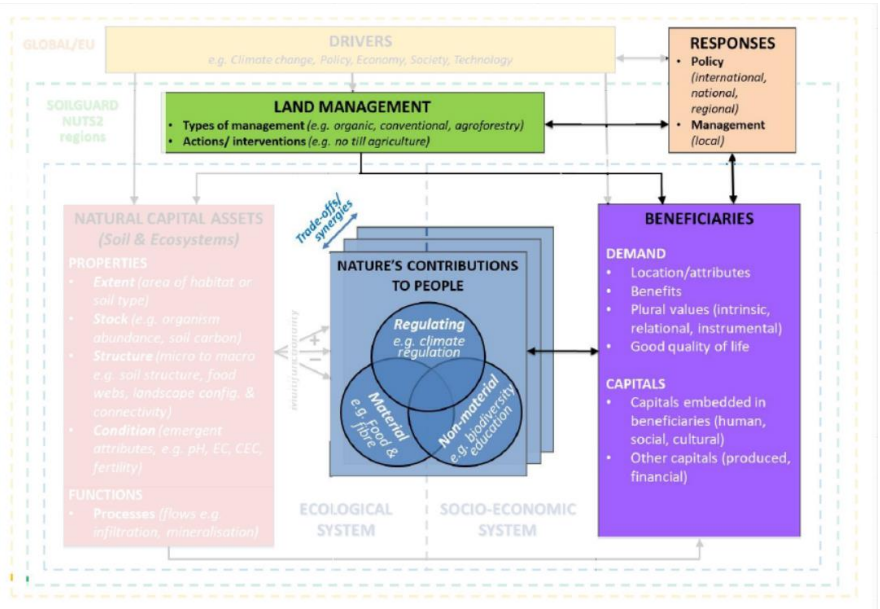


Figure 16. Elements and links from the SBWF considered in the assessment of the criterion: SSM practices have a positive impact on human wellbeing and the impact is periodically assessed

Guiding questions

Are human wellbeing outcomes relevant to the identified societal challenges identified? Are there benchmarks in place to monitor impact? Are outcomes and benchmarks assessed at regularly occurring intervals? Are human wellbeing outcomes incorporated into the strategy for the intervention? Is there a strategy for the intervention for how societal challenges will be addressed?

Score description

Strong	Adequate	Partial	Insufficient
Yes. SMART human well-being outcomes and benchmarks, relevant to the identified societal challenges and national/local context, are identified	Specific human well-being outcomes and benchmarks, relevant to the identified societal challenges and national/local context, are	General human well-being outcomes and benchmarks identified but no provision has been made for their assessment.	No. Human well-being outcomes are not identified or are vague and ill-defined with no benchmarks and no provision for assessment.

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

and are assessed at regularly occurring intervals.	identified and assessed at least once during the intervention period.		

7.2. Criteria related with beneficiaries

There are three criteria directly related to beneficiaries (Figure 17). These criteria are designed to assess: 1) the identification of stakeholders and beneficiaries, as well as the participatory, inclusive, transparent, and empowering nature of governance processes; 2) the acknowledgment and respect for the rights, usage, and access to land and resources, along with the responsibilities of different stakeholders; and 3) the economically feasibility of SSM practices.

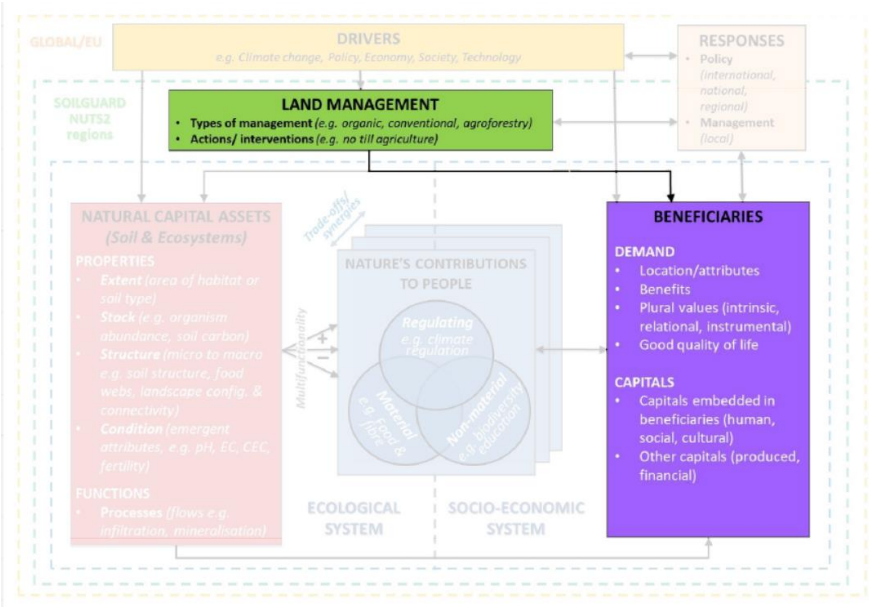


Figure 17. Elements and links from the SBWF considered in the assessment of the criterion related with beneficiaries

7.2.1. *The stakeholders and beneficiaries have been identified and governance processes are participatory, inclusive, transparent and empowering*

Description of the criterion

Stakeholders and local actors may have different interests, perceptions and preferences. Stakeholders who are directly and indirectly affected by the SSM practices should have been identified to have an inclusive governance process. This may encompass farmers, consumers, and civil society in broader terms. All affected stakeholders should be involved in all process of the intervention and participation must be based on mutual respect and equality, regardless of gender, age or social status. Participants should have appropriate channels to provide input, and their feedback must be meaningfully addressed. Decision-making processes document and respond to rights and interests of all participating and affected stakeholders Feedback and grievance resolution mechanisms should be established based on a model that is understood and accepted as legitimate by the involved stakeholders. Where the scale of the SSM practices extends beyond jurisdictional boundaries,

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

mechanisms are established to enable joint decision-making among the stakeholders in those jurisdictions affected by the SSM.

Guiding questions

Are all rights holders and beneficiaries identified and consulted? Is their impact and interest in the intervention mapped? Are there participation processes throughout the intervention timescale? Are the stakeholders who are directly and indirectly affected by the SSM system involved in all processes of the intervention? Do affected stakeholder accept and feel ownership over the outcomes of the intervention? Is participation based on mutual respect and equality? Are decision-making processes being documented and is this documentation transparent and accessible? Do decision-making processes respond to the rights and interests of all participating and affected stakeholders? Is specific attention paid to stakeholders subject to extreme inequity? Is there feedback and grievance resolution mechanism available to all stakeholders?

Score description

Strong	Adequate	Partial	Insufficient
Yes. The rights holders and beneficiaries have been identified. A robust multi-scale multi-sector stakeholder analysis was conducted to identify who may be directly and indirectly affected by the intervention. Affected stakeholders were involved in all processes and accept and own the outcomes. Decision-making processes take into account the rights and interests of all participating and affected stakeholders, with specific attention paid to stakeholders subject to extreme inequity. The procedures are documented and this documentation is transparent and accessible. A feedback and grievance resolution mechanism is developed in full consultation with affected stakeholders. If the intervention area extends beyond jurisdictional boundaries transboundary cooperation's agreements are created between affected stakeholders.	Most of the rights holders and beneficiaries have been identified. A stakeholder analysis was conducted identifying stakeholders who may be directly or indirectly affected by the SSM. Most stakeholders were then involved in the processes of the intervention although some gaps remain. Decision-making processes take into account the rights and interests of all participating and affected stakeholders. The procedures are documented and this documentation is transparent and accessible. A feedback and grievance resolution mechanism is developed in full consultation with affected stakeholders. If needed some transboundary cooperation's agreements are created.	Some of the rights holders and beneficiaries have been identified. Limited stakeholder analysis was conducted identifying only some of the stakeholder who may be directly or indirectly affected by the intervention. Some stakeholders have been engaged in the processes. Decision-making processes map rights and interests of all or some participating and affected stakeholders. The procedures are documented however no clear plan to take into account stakeholder decisions. Gaps remain and/or there is a lack of transparency or accessibility. A feedback and grievance resolution mechanism is developed with limited input from some affected stakeholders. There is a lack of transboundary cooperation agreements.	No. Any rights holders and beneficiaries have been identified. No stakeholders were involved in the processes. Decision making processes do not take into account rights and interests of stakeholders and/or are not documented. A feedback and grievance resolution mechanism is not or only partially developed with no consultation with affected stakeholders. Not know whether or where SSM intervention area extends beyond jurisdictional boundaries.

7.2.2. *The rights, usage of and access to land and resources, along with the responsibilities of different stakeholders are acknowledged and respected*

Description of the criterion

SSM practices can have an impact on natural resources, which are often managed collectively by various stakeholders. In this context, SSM must not privilege one group at the expense of another in terms of rights, land use, and access to resources. Legal and customary rights pertaining to access, use, and management control over land and natural resources, especially for vulnerable and marginalized

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

groups, must be respected. The rights, usage, and responsibilities of stakeholder groups in relation to SSM practices should be thoroughly analysed and assessed, employing suitable tools and building upon the findings of stakeholder analysis or mapping.

Guiding questions

Are the rights, usage of and access to land and resources as well as stakeholder responsibilities identified? Are they incorporated into a stakeholder mapping analysis? Are they acknowledged and respected? Do they inform the design of the intervention?

Score description

Strong	Adequate	Partial	Insufficient
Yes. All the rights, usage of and access to land and resources, as well as stakeholder responsibilities are analysed using a stakeholder mapping/analysis. Rights, usage of and access to land and resources are respected and inform the design of SSM practices.	Most rights, usage of and access to land and resources, as well as responsibilities were analysed using a stakeholder mapping/analysis. All those analysed are acknowledged and respected although knowledge gaps persist in some areas or parts of the SSM practices.	Some rights, usage of and access to land and resources, as well as responsibilities are analysed. However, this was not done using appropriate tools and not linked to the outcomes of stakeholder analysis or mapping with only few stakeholders considered. Only some of those analysed are acknowledged and respected.	No. The rights, usage of and access to land and resources, as well as responsibilities are not identified.

7.2.3. *SSM practices are economically viable*

Description of the criterion

The direct and indirect benefits and costs associated with the SSM, along with identifying who pays and who benefits, should be identified and documented, considering the costs and benefits associated with trade-offs. Potential costs and benefits, including those associated to the trade-offs of the intervention, should be explicitly recognized throughout the entire intervention lifecycle. A cost-effectiveness study should support the selection of SSM practices, taking into account the potential impact of any applicable regulations or subsidies. The cost-effectiveness and affordability of the SSM design should be justified against other available alternative solutions. Additionally, SSM should explore various resourcing options, such as market-based or public-sector approaches.

Guiding questions

Are the direct and indirect benefits and costs associated with the SSM practices overtime and who receives them identified? Is this fully documented and verified? Is cost-effectiveness analysed? Are the potential SSM costs and benefits of associated trade-offs explicitly acknowledged? Are available alternative solutions identified? Is the intervention design's effectiveness justified against available alternative solutions? Is this justification documented? Is there a comprehensive review of resourcing options? Has a full resourcing package been assembled and negotiated? Does this resourcing package include provision for future revenue streams?

Score description

Strong	Adequate	Partial	Insufficient

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

Yes. All the main direct and indirect costs and benefits have been analysed, verified and are fully documented. The analysis considers costs and benefits related with trade-offs, both at the SSM site and the larger landscape/seascape, throughout the intervention time-scale the distribution of the costs and benefits are well understood. A full cost effectiveness study has been conducted. The long-term economic and financial sustainability is well understood as well as the economic risks. The effectiveness and affordability of the intervention against the next best alternative(s) are fully justified, understood and documented. A comprehensive review of resourcing options has been undertaken and a full resourcing package has been assembled and negotiated, including provision for future revenue streams	Analysis of costs and benefits includes both financial and non-financial elements and a clear description of indirect costs and benefits. The cost benefit analysis considers trade-offs and most spatial and temporal dimensions. There is a good understanding of how costs and benefits are distributed but limited verification. A cost effectiveness study is available. The long-term affordability and economic and financial sustainability are broadly understood and justified. The principle source of long-term funding is identified and secured. Potential sources of complementary resourcing have been identified and thoroughly assessed. A comprehensive resourcing package has been identified but it has not yet been negotiated. There are some gaps in the economic analysis.	The analysis of costs and benefits includes financial and non-financial aspects, but there are gaps, especially in understanding indirect costs and benefits. The analysis only considers the SSM site and/or only for specific parts of the SSM lifecycle. While there is a general understanding of major cost and benefit distribution, it lacks comprehensiveness and verification. A basic analysis has been conducted, but indirect costs and benefits are not fully accounted for. Viable alternative solutions have been identified and documented, along with their pros and cons, but economic analysis is limited. The main source of long-term funding is identified and secured, and potential complementary funding sources have been identified but require further analysis.	No. Identification of costs and benefits is limited only to the immediate and direct financial transactions of the initiative. The costs and benefits related with trade-offs are not analysed. Understanding of how costs and benefits are distributed is superficial. A basic analysis has not yet been conducted, and the flow of benefits over time compared to initial and ongoing costs has not been analysed. There has been no meaningful review of the proposed intervention's cost effectiveness against other viable alternatives. There is no clear understanding or guarantee of even the main funding source required to cover piloting phase. There has been no analysis of potential future or complementary revenue options.

7.3. Criteria related with responses

7.3.1. *Lessons learned are documented and shared*

Description of the criterion

The design and implementation process should efficiently capture, document, and share lessons learned with individuals and stakeholders interested in replicating the procedure. This includes decision-makers, investors, and other users from both the public and private sectors. Figure 18 describes the elements and links considered in the assessment of this criterion.

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

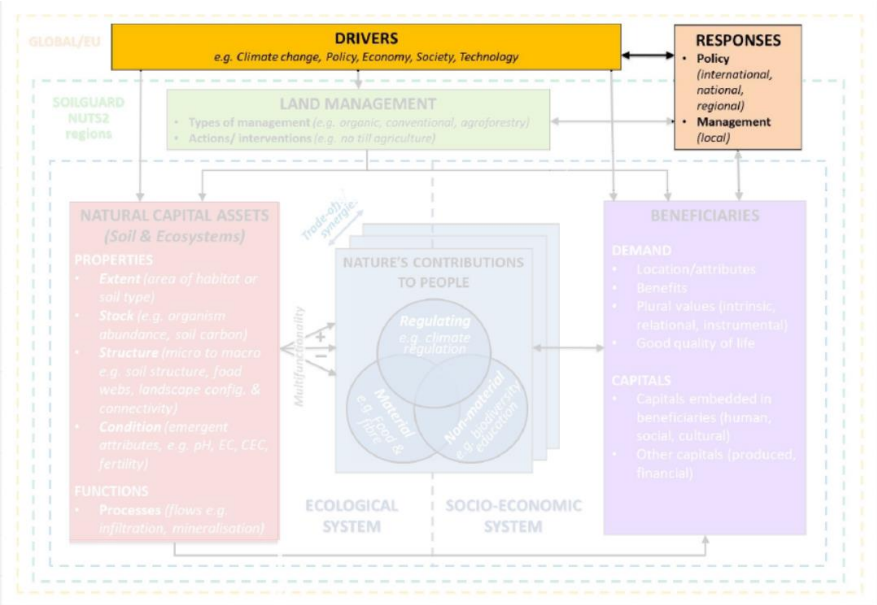


Figure 18. Elements and links from the SBWF considered in the assessment of the criterion: Lessons learned are documented and shared

Guiding questions

Are design, implementation and lessons learnt being systematically shared? Is this sharing accessible to target audiences? Is a communication strategy in place? Does this strategy detail how communication will change behaviours and how this will trigger transformational change?

Score description

Strong	Adequate	Partial	Insufficient
Yes. There is a learning framework that is applied throughout the intervention lifecycle and that is used continuously to learn and adapt in response to results of the monitoring and evaluation plan. Strategy in place for how learning would persist beyond time frame of intervention. Trade-offs are respected and periodically reviewed throughout the intervention time scale. The adaptative management and learning processes are documented. Actions to mitigate possible adverse impacts of SSM on ecosystems, ecological process and species are mobilized. The plan includes how deviations from the strategy trigger an adaptive management response.	There is a learning framework that is applied at different stages of the intervention lifecycle. It is linked to the monitoring and evaluation plan. Mutually agreed upon limits of some trade-offs are respected and safeguards are occasionally reviewed. A clear process for how deviations will trigger an adaptive management response is lacking. Actions to mitigate possible adverse impacts of SSM on ecosystems, ecological process and species are mobilized. However, lack of clarity on how actions will be mobilised and resourced.	Incomplete learning framework lacking clarity on how monitoring and evaluation will lead to learning and adaptation. Mutually agreed upon limits of only a few trade-offs are being respected and few safeguards are sporadically reviewed. A clear process for how deviations will trigger an adaptive management response is lacking. There is a general identification of possible impacts of SSM practices at ecosystem level and plans to mitigate those impacts are in place.	No. Incomplete or no learning framework. Mutually agreed upon limits of trade-offs have not been considered and no safeguards have therefore been put in place. No link to how the plan could trigger an adaptive management response. There is no identification of potential impacts of SSM practices and these impacts are not assessed.

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

7.3.2. *SSM practices are managed adaptively, based on iterative learning*

Description of the criterion

The monitoring and evaluation plan should facilitate iterative learning and inform adaptive management actions to respond to changing factors influencing SSM. Learning based on the evidence gathered though the monitoring and evaluation plan should drive SSM practices and trigger specific responses when mutually agreed limits are exceeded. Iterative learning is essential for informing adaptive management actions that respond to the factors influencing SSM and establishing safeguards to prevent adverse consequences. Safeguards may be put in place for Natural Capital Assets and soil biodiversity (e.g. setting aside a certain area for protection or limiting the timing of fishing) and for beneficiaries (e.g. procedural - grievance mechanisms, consultation obligations, right to appeal or substantive - contracts, legal and regulatory provisions). Observed and sustained deviations from the key elements of the SSM practices should trigger an adaptive management response. Figure 19 describes the elements and links considered in the assessment of this criterion.

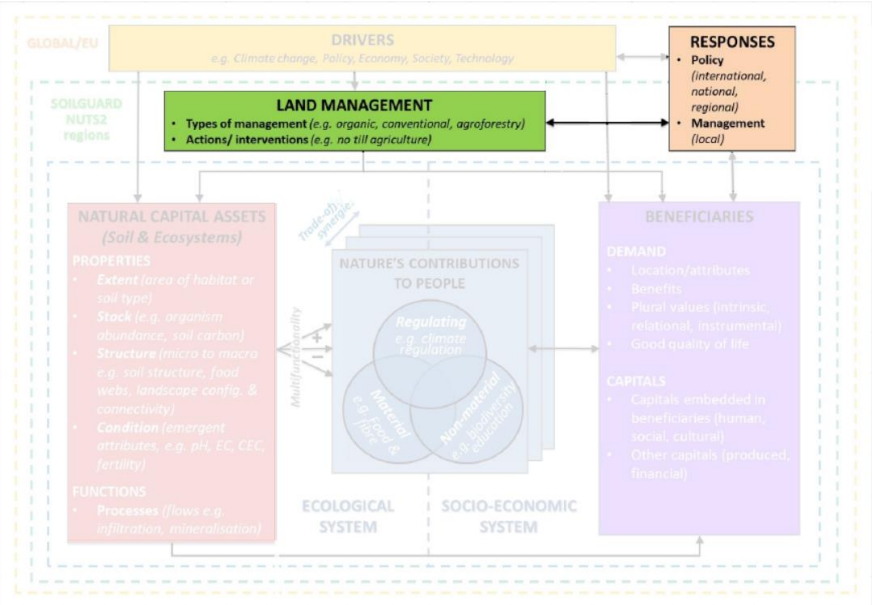


Figure 19. Elements and links from the SBWF considered in the assessment of the criterion: SSM practices are managed adaptively, based on iterative learning

Guiding questions

Is there a plan to learn and adapt in response to the monitoring and evaluation plan? Is there a learning framework applied to the SSM practices for iterative learning throughout the intervention lifecycle? Does this enable adaptive management?

Are there mutually agreed limits of trade-offs being respected? Are there established safeguards in place to prevent these being exceeded or to prevent trade-offs destabilising the entire ecosystem or land/seascape? Are actions in response to risks and adverse impacts in place according to the monitored information? Does this plan include how deviations of the strategy trigger an adaptive

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

management response? Are actions in response to those impacts in place? Is the monitoring plan properly implemented with measurements taking place at periodic intervals?

Score description

Strong	Adequate	Partial	Insufficient
Yes. There is a learning framework that is applied throughout the intervention lifecycle and that is used continuously to learn and adapt in response to results of the monitoring and evaluation plan. Strategy in place for how learning would persist beyond time frame of intervention. Trade-offs are respected and periodically reviewed throughout the intervention time scale. The adaptative management and learning processes are documented. Actions to mitigate possible adverse impacts of SSM on ecosystems, ecological process and species are mobilized. The plan includes how deviations from the strategy trigger an adaptive management response.	There is a learning framework that is applied at different stages of the intervention lifecycle. It is linked to the monitoring and evaluation plan. Mutually agreed upon limits of some trade-offs are respected and safeguards are occasionally reviewed. A clear process for how deviations will trigger an adaptive management response is lacking. Actions to mitigate possible adverse impacts of SSM on ecosystems, ecological process and species are mobilized. However, lack of clarity on how actions will be mobilised and resourced.	Incomplete learning framework lacking clarity on how monitoring and evaluation will lead to learning and adaptation. Mutually agreed upon limits of only a few trade-offs are being respected and few safeguards are sporadically reviewed. A clear process for how deviations will trigger an adaptive management response is lacking. There is a general identification of possible impacts of SSM practices at ecosystem level and plans to mitigate those impacts are in place.	No. Incomplete or no learning framework. Mutually agreed upon limits of trade-offs have not been considered and no safeguards have therefore been put in place. No link to how the plan could trigger an adaptive management response. There is no identification of potential impacts of SSM practices and these impacts are not assessed.

7.3.3. *A monitoring and evaluation plan is implemented to assess unintended adverse consequences on nature and review the established safeguards.*

Description of the criterion

A monitoring and evaluation plan must be developed and implemented throughout the intervention lifecycle to assess whether the SSM practices effectively achieves the intended outcomes and to determine if risks, unexpected impacts, or observed deviations require responses or corrective actions. Synergies with other interventions or approaches, should be included in the monitoring and evaluation plan. The monitoring and evaluation of the SSM practices should be based in a strategy that includes the reasoning behind the practice, a precise articulation of the intended outcomes and clear understanding of how these should be achieved through the actions taken. Monitoring includes periodic assessments for unintended adverse consequences on nature arising from the SSM practices and established safeguards must be periodically reviewed to anticipate and avoid adverse consequences of interventions, especially considering that inequity in trade-offs may change over time and that not all stakeholders may be equally affected. Figure 20 describes the elements and links considered in the assessment of this criterion.

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

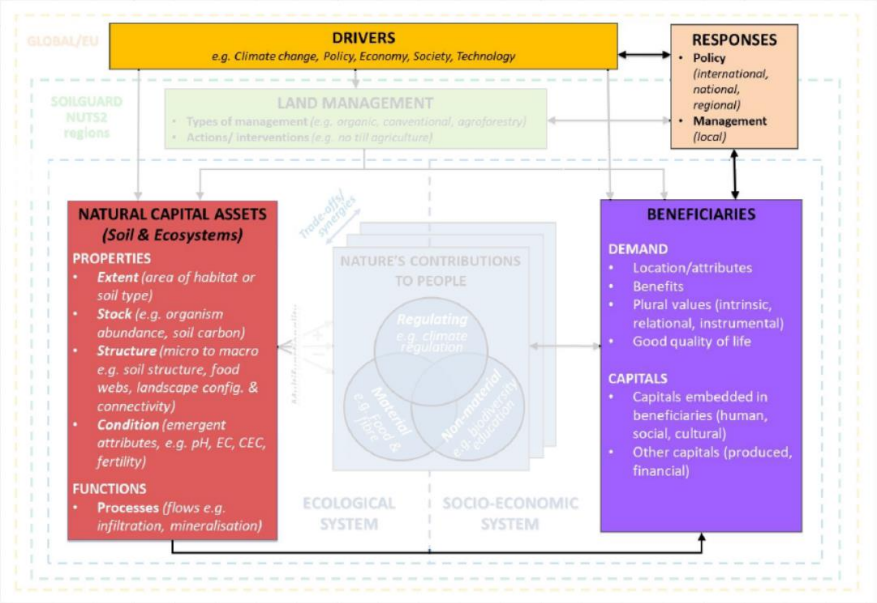


Figure 20. Elements and links from the SBWF considered in the assessment of the criterion: A monitoring and evaluation plan is implemented to assess unintended adverse consequences on nature and review the established safeguards.

Guiding questions

Is there a robust monitoring and evaluation plan in place? Is it being implemented throughout the lifecycle of the intervention? Are complementary interventions and synergies re-assessed throughout the intervention time scale? Is there a strategy for the intervention for how societal challenges will be addressed? Does the strategy precisely state intended outcomes, actions and assumptions in regards to economic, social and ecological conditions? Does the strategy elaborate on whether and how assumptions may change? Is it consistently being used as a basis for regular monitoring and evaluation of the intervention? Is a monitoring and assessment plan in place for ecosystems, species and ecological processes? Is the monitoring plan based around measurable variables related to potential adverse impacts on nature arising from the SSM, both direct and indirect? Are these safeguards being periodically reviewed? Is clear documentation of safeguards and their review provided?

Score description

Strong	Adequate	Partial	Insufficient
Yes. A monitoring and evaluation plan is in place and the monitoring follows a regular basis. There is a strategy that states intended outcomes, actions and assumptions made in regards to economic, social and ecological conditions. The strategy elaborates on how assumptions may change and is consistently used a basis for monitoring and evaluation of the intervention. Possible adverse impacts of SSM interventions on ecosystems, ecological process and species identified. A monitoring and evaluation	A monitoring and evaluation plan is in place but the monitoring does not follow a regular basis. A strategy is established that states intended outcomes, actions and assumptions relevant to the current context. The strategy is used to inform monitoring and evaluation of the intervention in the design and implementation stage. Possible adverse impacts on ecosystems, ecological process and species, have been	A monitoring and evaluation plan is in place but the monitoring does not follow a regular basis. A strategy is established that states some intended outcomes, actions and assumptions. The strategy does not inform the monitoring and evaluation of the intervention and/or does not take into account changing assumptions. There is a general identification of possible impacts of SSM	No. Incomplete or no monitoring and evaluation plan in place. Incomplete or no strategy established, with no link to economic, social and ecological conditions and little link to monitoring and evaluation of the intervention. There is no identification of potential impacts of SSM practices interventions and these impacts are not assessed. No

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

system of potential adverse impacts is properly implemented. Safeguards are periodically reviewed with clear documentation of this being provided.	identified. A monitoring plan for assessing adverse impacts is under development. Safeguards are occasionally reviewed, with documentation provided	practices at ecosystem level and plans to mitigate those impacts are in place. Safeguards are sporadically reviewed. There is no documentation of the process	safeguards have therefore been put in place.

7.3.4. *Relevant policies, regulation frameworks and national and global targets are identified and considered in the SSM practices design*

Description of the criterion

Given that SSM practices are influenced by various policies, laws, and sectoral regulations, it is crucial to identify policy, regulatory, and legal constraints. SSM practices could be supported by EU or national subsidies such as CAP mechanisms that should be adequately considered. Figure 21 describes the elements and links considered in the assessment of this criterion.

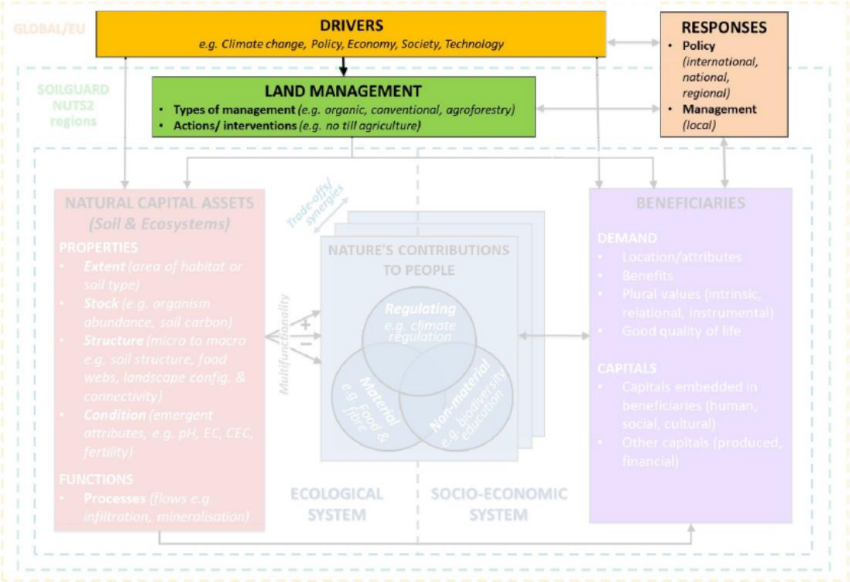


Figure 21. Elements and links from the SBWF considered in the assessment of the criterion: Relevant policies, regulation frameworks and national and global targets are identified and considered in the SSM practices design

Guiding questions

Are policy, regulations and laws relevant to the intervention being identified? Are their impacts and opportunities being mapped? Are relevant national and global targets for human wellbeing, climate change, and biodiversity and human rights being identified? Are these policies and targets considered in the design of SSM practices?

Score description

Strong	Adequate	Partial	Insufficient

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

SMM practices actions incorporate a review of policy, regulations and laws that are relevant to the SSM, that can be used to support their uptake and mainstreaming. Relevant national and global targets for human wellbeing, climate change and biodiversity have been identified.	The policy, laws and regulations relevant to the SSM were identified and taken into account and their potential use to support SMM or were partially included. Relevant national and global targets for human wellbeing, climate change and biodiversity have been identified.	Some relevant policy, regulations or laws were identified but knowledge gaps (e.g. their potential use to influence the SSM) remain and no link to them was thought of or planned. Some national and global targets for human wellbeing, climate change and biodiversity have been identified.	No. The SSM operational plans have not been framed within the context of prevailing land-use and other relevant policies, regulations or laws. No relevant national and global targets for human wellbeing, climate change and biodiversity have been identified

7.3.5. *SSM practices inform and enhance facilitating policy and regulation frameworks and contribute to national and global targets*

Description of the criterion

SSM strategies should ideally inform and facilitate policy and regulatory frameworks to support their adoption and mainstreaming. Collaboration with local and/or national decision-makers, as well as other key stakeholders, is essential to highlight such barriers and identify effective responses or enabling solutions. SSM can also play a significant role in achieving national economic, social, and environmental targets and commitments for human wellbeing, climate change, biodiversity and human rights linked to international initiatives. These contributions should be made explicit, documented, and communicated. Figure 22 describes the elements and links considered in the assessment of this criterion.

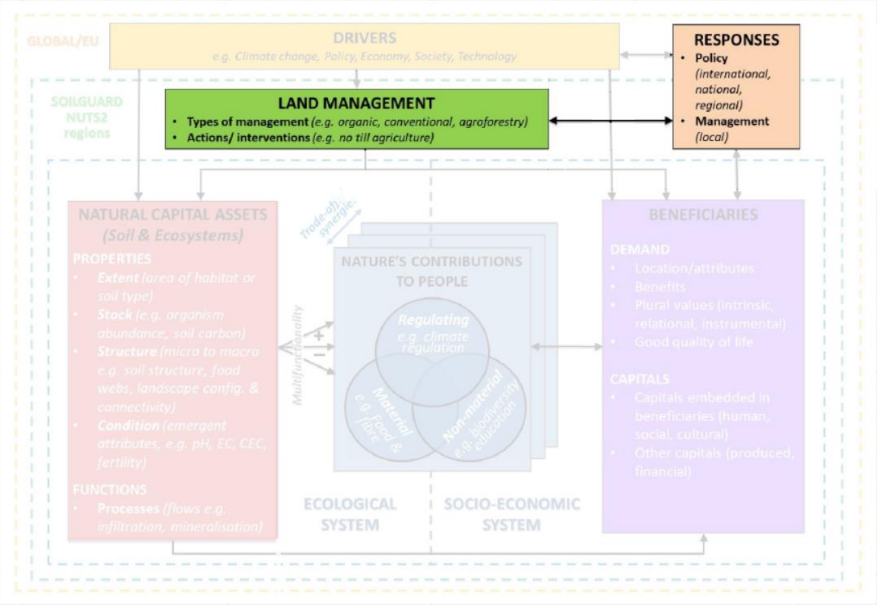


Figure 22. Elements and links from the SBWF considered in the assessment of the criterion: SSM practices inform and enhance facilitating policy and regulation frameworks and contribute to national and global targets

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.

Guiding questions

Are the interventions actions and communications informing or enhancing facilitating policy and regulation frameworks? Are the interventions actions contributing to any of the identified targets? Is this contribution being reported in relevant platforms?

Score description

Strong	Adequate	Partial	Insufficient
Yes. Policy, regulations and laws have been reviewed. Where necessary and possible, the SSM system may inform and enhance policy frameworks amendment. Relevant national and global targets for human wellbeing, climate change and biodiversity have been identified. The potential contribution of the SSM to these targets was identified and is reported in the relevant platforms	The policy, laws and regulations relevant to the SSM system were identified and considered as part of the design of the SSM system. The potential use of SSM to support policy and regulation amendment, were partially included. The potential contribution of the SSM to relevant national and global targets for human wellbeing, climate change and biodiversity was partially identified and partially reported in the relevant platforms.	Some relevant policy, regulations or laws were identified, but knowledge gaps remain and no link to them was thought of or planned. The potential contribution to some national and global targets for human wellbeing, climate change and biodiversity was only partially identified and not reported in the relevant platforms.	No. The SMM system has not been framed within relevant policies, regulations or laws and has not engage with other key stakeholders on issues that related to enabling policy, legal and regulatory frameworks. The potential contribution of the SSM to relevant national and global targets for human wellbeing, climate change and biodiversity targets was not identified and nor reported in the relevant platforms.

The research leading to these results has received funding from the European Union Horizon 2020 Research & Innovation programme under the Grant Agreement no. 101000371.