Soils for SOLO Europe

Guidelines for the development of the Think Tanks and Soil Network of Knowledge Strategy

Deliverable D2.1

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Summary

The following report constitutes a reference document for the SOLO Think Tanks conceptualisation, structure, and implementation. In this sense, this document is a guideline for the Think Tanks to be used (together with the description of Terms of Reference in D2.2).

On one hand, concepts regarding transdisciplinarity, engagement and multiactor approaches and co-creation techniques are defined. Additionally, our understanding of the main elements that each Think Tank should include as common elements is also described. The structure and functioning of the Think Tanks are here included with templates and examples. In this regard, the inherent flexibility on the Think Tanks represents a key element to adapt both bottom-up and top-down needs during SOLO. A methodology for evaluating the engagement process is also included.

The main outcome from the Think Tanks is the roadmaps they will produce. Then, the document elaborates on roadmapping processes and drafts a template for the Think Tanks to start the co-creative process with it.

The document incorporates the Soil Network of Knowledge also considered a black bone in SOLO beyond the project as well as the further uptake of the project dynamic Roadmaps and Operational framework. The strategy to follow within the Soil Network of Knowledge, including the conceptualisation and structure, is also described here.

- **List of abbreviations**

EU	European Union
KPIs	Key Performance Indicators
R&I	Research and Innovation
RN	Regional Nodes
RRI	Responsible Research and Innovation
SMO	Soil Mission Objectives
SNK	Soil Network of Knowledge
SOLO	Soils 4 Europe Project
ToR	Terms of Reference
TT	Think Tanks

1 Introduction

This deliverable is focused on construction guidelines for the SOLO Think Tanks to be operational, giving them foundations and common ground to be created, expand, and interact among them.

We understand it as an initial guideline from which the 10 Think Tanks can rely on. The main aim of the SOLO Think Tanks is here defined together with a common vision and structure. The importance of transdisciplinarity and multiactor approach is also described and highlighted in this deliverable together with a wide array of the methodologies they can follow. A specific section describing different roadmaps structures and processes is included, highlighting which should be the roadmap process to follow per all the Think Tanks.

Therefore, this deliverable, together with D2.2 (Terms of Reference) give the core to the Think Tanks in SOLO as individual groups but also guides them stablishing the workflow comprising both their interaction with other TT and allowing to interact with other scales: creating an overarching TT among them and incorporating a common ground with the regional nodes and their roadmaps. This workflow naturally includes the interaction with other work packages, emphasizing the need of synthesis from WP4, and the dialogue with WP3 regarding the soil drivers. Equally important is the definition of Key Performance Indicators, KPIs to be developed in WP5.

Finally, a monitoring/ evaluation phase of the engagement developed during the project is also included. We understand the roadmaps before anything, a process by itself. Therefore, this additional step also allows us to be flexible, learning by doing and at a time we are adapting to the requirements that may arise, we are aware and evaluate the process, its orientation, and results.

1.1 Project background

The main goal of SOLO is to deliver actionable transdisciplinary roadmaps for future soil-related research activities in the EU, which contribute to achieving the objectives of the Soil Mission. This will be done by working on three axes: i) identification of the major knowledge gaps in research, driving forces and bottlenecks (10 Think Tanks); ii) assessment of synergies and trade-offs between the roadmaps of the Soil Mission Objectives and European regions (Regional Nodes), and iii) co-development of an Operational Framework and a set of indicators to monitor the Soil Mission progress.

Concisely, the Soil Mission Think Tanks aim to identify knowledge gaps and novel avenues for European soil research, innovation, and other actions in the context of the Soil Mission objectives. The Think Tanks goals as trigger and deployment of participative action research processes are:

- ➔ Co-develop the Mission Objective roadmaps,
- ➔ Facilitate knowledge exchange
- ➔ Establish a strong connection to current and future EU and international Soil Health projects.

1.1.1 Objectives

This deliverable tackle two main objectives. First, to guide the SOLO TT on its development both methodologically and engagement wise. For that purpose, a description of how we conceive transdisciplinary research and what we understand for engagement is included as a first step. Then, an initial description of the TT actions, results, and outputs, together with its internal organization is incorporated. Additionally, we present a further description of roadmaps and roadmapping understood in SOLO as a process by itself and not as a mean. Finally, how this could be embodied into the roadmaps is included.

The second objective is to describe the SOLO Soil Network of Knowledge, SNK. What is our understanding in the project of the SNK and how we are planning to interact among different knowledge holders, users and potential reviewers is described. How strategically we are planning to work in the SNK and which interactions it should have with the TT and the overall project is also described here.

In SOLO, transdisciplinarity and engagement practices are considered paramount for the success of the project. Therefore, engaging users at regional, national, and European level to support the co-design of comprehensive research and innovation roadmaps for the European Soil Mission is key. To start this process 'why', 'who', 'when' 'what' 'where' and 'how' to engage has been discussed with the partners which allow us to provide guidance on the planning engagement activities, including managing conflict and monitoring outcomes through the SOLO TT. This transdisciplinary will make the integration across disciplines a central element of SOLO and make decision processes, business models and policy impacts to be the object of research and the co-creation of solutions for change.

Additionally, the SNK, a knowledge and innovation network of regional, national and European connects that will include members from multiple sectors including soil scientists, soil ecologists, social scientists and economists, anthropologist and psychologists, climate researchers, governance specialists, policy and lawmakers, NGOs, corporations, retailers, food quality and safety organizations, space agencies and Earth observation researchers, institutions related to impact assessment, restoration and remediation, consumer organizations, and educators. This wide range of stakeholders will also ensure that SOLO presents a comprehensive and evidence-based overview of the needs, bottlenecks and major research and innovation pathways related to the improvement of soil health.

The SOLO TTs will be expanded through the implementation of an open participatory platform at the core of the project. This platform (based on ARPHA by PENSOFT) will reduce stakeholder fatigue and enhance their contribution to the project outputs. Constituted as a "*Soil Network of Knowledge*" this basis of stakeholders will also benefit from and be beneficial to the future Soil Mission citizen's engagement process and will ensure the maximization of the impact of SOLO.
The KPIs described for these actions are: i) a Development of 1 Soil Network of Knowledge, ii) 1 stakeholder database, and iii) up to 500 stakeholders engaged.

1.2 SOLO Think Tanks

The SOLO Thinks Tanks are conceptualised as groups of key people brought together to co-define and co-develop ideas, based on a common understanding of needs around soil problems and to make suggestions for action for the future research in soils in Europe.

Think Tanks here function as an operational tool for implementing a participatory process by approaching key people to express their views and knowledge on various soil issues and to articulate research needs among all.

Each Think Tank of the SOLO project is coordinated by one or two institutions or organizations from the consortia of the project who led the TT, giving structure, boosting motivations, fostering dynamics of engagement, and drive the coproduction of the outputs of the project. For those purposes, these guidelines, together with the ToR (D2.2) are considered the dorsal spine where the engagement process lies on. Additionally, each TT group is constantly being supported and steered, both in terms of processes and outcomes through a specific task of the project (T2.1).

We predefine each Think Tank consisting of up to 30 members representing SOLO partners and key stakeholders from different spheres. We follow the 5helix model (Figure 1) and adapted from that we select key groups of stakeholders to be included into the Think Tanks (Figure 2).

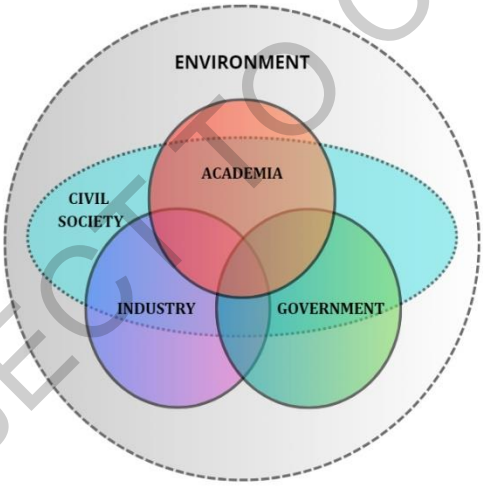

Figure 1: Quintuple Helix model. Modified from Faulds 2019.

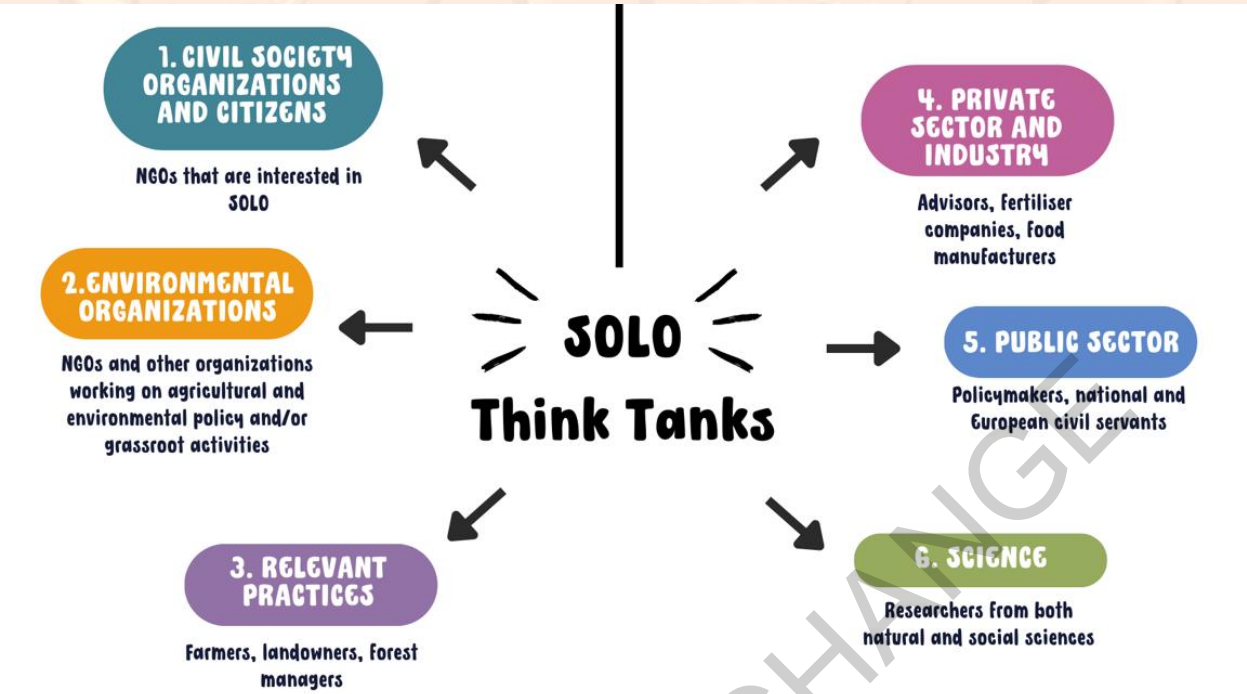

Figure 2: Key stakeholders targeted in SOLO following the 5-helix model.

These key actors are the ones that will provide input and feedback on the work of the Think Tank in diverse manners to the degree of their availability (ranging from filling in questionnaires to be involved as co-author of the work produced). As mentioned, we understand the cornerstone of the TT the stakeholders involved, and therefore their engagement is paramount and starts from the outset.

In this sense it needs to be highlighted that, as a transdisciplinary, *fair,* and multiactor approach, we open each TT definition and development for discussion to define together what we understand by the objective, and how research questions will be approached within each Think Tank. Therefore, as previously mentioned, this is an open process in which we aim to co-create the main actions and outcomes for each Think Tank.

1.2.1 What are the Think Tanks Initial Missions?

Think Tanks catalyse the collaboration of key stakeholders of the Soil Mission and lay out a clear pathway for research to reach the 8 goals of the Soil Mission in Europe, plus an extra goal related to the biodiversity and conservation of nature, namely:

- ➔ Reduce land degradation
- ➔ Conserve soil organic carbon stocks
- ➔ Stop soil sealing and increase re-use of urban soils
- ➔ Reduce soil pollution and enhance restoration
- ➔ Prevent soil erosion
- ➔ Improve soil structure to enhance soil biodiversity
- ➔ Reduce the EU global footprint on soils
- ➔ Improve soil literacy in society
- ➔ Nature conservation of soil biodiversity
- ➔ Climate Smart Agriculture

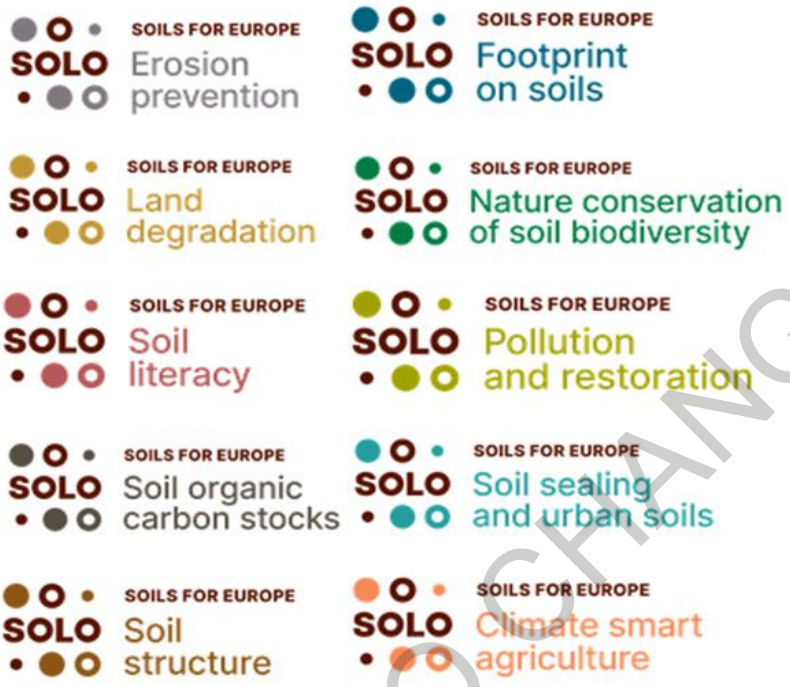

Figure 3: Logos for each SOLO Think Tank

1.2.2 Think Tanks main goals and expected achievements

The SOLO Think Tanks will be developed as knowledge-based lobby groups to develop a visionary roadmap to the future of research and innovation in Europe. Achieving this goal requires constant interaction with several European bodies and a constant update of the main knowledge gaps found. Therefore, the different Think Tanks aim m primarily to deliver through the course of the project but specially by 2027, an actionable trans-disciplinary roadmap for future soil-related research activities in the EU that contribute to achieving the objectives of the Soil Mission. This implies identifying knowledge gaps, drivers, and bottlenecks that may hinder or create opportunities for future research and innovation. This effort includes not only identifying gaps in knowledge but also in supporting institutional background and proposing new avenues to limit the challenges for the next decade.

1.2.3 What will the Think Tanks produce?

As mentioned, the SOLO Think Tanks will identify knowledge gaps and novel avenues for European soil research, innovation, and action in the context of the Soil Mission specific and operational objectives.

For that purpose, each Think Tank will address one of the Soil Mission Objectives and produce an overview on that topic, therefore positioning the main issues related to this objective. The Think Tanks will emphasize the drivers, barriers, and knowledge gaps of their own specific Soil Mission Objective through participatory (transdisciplinary) processes.

Concisely, the outputs will be a scoping document and a roadmap which will impact future research in this field in Europe.

The scoping document and the roadmap produced by each of the SOLO Think Tanks will include:

i) a preliminary assessment of knowledge gaps and novel avenues for soil health research and innovation in Europe including priorities and a timeline,

ii) the identification of novel technical and technological developments that benefit the implementation of the Soil Mission objective,

iii) the identification of major bottlenecks and risks for the implementation of the Soil Mission and the fulfilment of its specific and operational objectives,

iv) the identification of legislative and institutional barriers that might hinder the impact of the Mission research and innovation activities; and,

v) the definition of key performance indicators to monitor the achievement of the R&I priorities defined in the Soil Mission.

In addition, Think Tanks will produce a preliminary selection of critical drivers for each relevant land-use type. The list of drivers will include technology and management, nature and environment, policy and institutional arrangements, demography, socio-cultural contexts, and economy.

Think Tanks will also be consulted for the analysis of the technical, social, economic, and cultural options for achieving the Soil Mission specific objectives. They will address aspects related to social and economic factors, governance, institutional arrangements, markets, environmental and ecological factors, and legal aspects that may prevent the effective implementation of R&I solutions.

Ultimately, all the work performed by the Think Tank will provide the building blocks for an Operational Framework for monitoring the Mission R&I portfolio via the setting of key performance indicators (KPIs).

2 Multi actor approach and transdisciplinary research in SOLO

2.1 Introduction to transdisciplinary research

It is well known nowadays that research production has evolved into a more transdisciplinary process for a wide variety of reasons. One of the most enlightening is the introduction of several

actors which can be extremely enriching when analyzing a certain issue since it conducts investigations considering all different perspectives and areas of knowledge.

Nevertheless, there have been some misinterpretations around the definition of transdisciplinary research and what it entails. For example, the terms interdisciplinary and multidisciplinary are frequently confused with one another and used interchangeably. Therefore, it is valuable to clarify and understand the implication of these concepts to implement them accurately.

Hence, *"multidisciplinary research is the cooperation of researchers from several different disciplines, but each working in their own context with little cross-fertilization among disciplines, primarily sharing information and results at the end of the research to support the overall combined findings."* Thereby, *"Interdisciplinary research in contrast involves a much closer interaction, including transferring methods and knowledge between the academic disciplines (sometimes in turn leading to the development of what are eventually considered new academic disciplines, with their own characteristic knowledge, approaches, and boundaries to their disciplines); like the long history of transdisciplinary, extensive work has also gone into understanding forms of interdisciplinary integration of knowledge".*

The introduction of "transdisciplinary" and *"transdisciplinarity"* terminology is mostly attributed to a conference on transdisciplinarity in 1970. Moreover, *"awareness of the need for more effective interaction between the academic and policy communities to support social transformations*" (Lawrence et al., 2021, p.46) was raised during the 1992 EU Earth Summit that took place in Rio de Janeiro (Brazil).

Noteworthy, there is a wide range of definitions when it comes to transdisciplinary process and its characteristics. As an illustrative example, we include here Figure 4 and 5 as two different ways of explaining and communicating them.

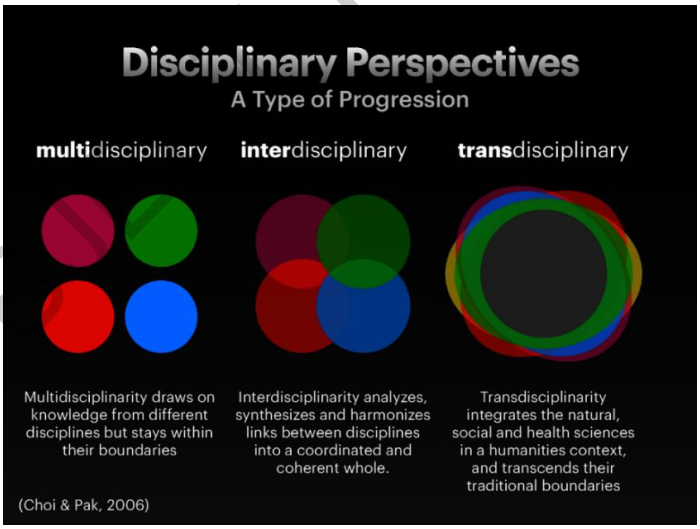

Figure 4: Illustrative example of multi, inter and transdisciplinarity, emphasizing its progressive dimension.

Source: Choi &Pal 2006, cited in April 2020 by Jacob Campbell

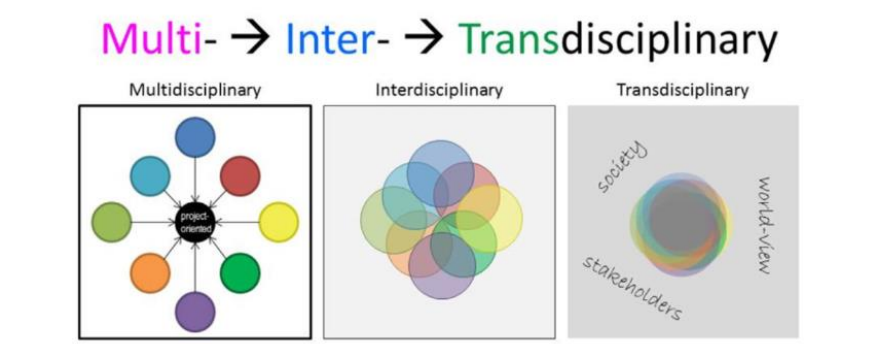

Figure 5: Illustrative example of multi, inter and transdisciplinarity, emphasizing the understanding of the society, the actors involved and their worldviews.

Source: Wasla Zainab Awan March1, 2022

On the other hand, Lang et al., (2012, p.26) defines that *"transdisciplinarity is a reflexive, integrative, method-driven scientific principle aiming at the solution or transition of societal problems and concurrently of related scientific problems by differentiating and integrating knowledge from various scientific and societal bodies of knowledge.".* Furthermore, Lawrence et al., (2021) emphasizes the fact that this type of investigation does not pretend to replace other scientific methods, such as: disciplinary and interdisciplinary approaches.

We highlight here Lawrence et al., (2021, p.47) **seven key features** distinguished that are mentioned (explicitly or implicitly) in the literature:

1) a focus on theorical unity of knowledge, in an effort to transcend disciplinary boundaries,
2) the inclusion of multidisciplinary and interdisciplinary academic research,
3) the involvement of (non-academic) societal actors as process participants,
4) a focus on specific, complex, societally relevant, real-world situations or problems,
5) working in a transformative manner, i.e., going beyond the focus on real-world problems to actively support action or intervention,
6) an orientation toward the common good (including the betterment of society and humanistic reverence for life and human dignity),
7) reflexivity, i.e., consciously contemplating the broader context and ensuring the combability of the project's components and task throughout the course of the project.

We understand that SOLO project relies on this concept of transdisciplinarity, going beyond multiactor approach. Therefore, SOLO TTs follow those 7 key features above-mentioned.

Furthermore, we also introduced another set of essential elements that constitutes transdisciplinary research (Dennison, 2017):

1) Transdisciplinary research is best applied to complex problems.

Transdisciplinary is usually used to address problems that are the most difficult to solve. Therefore, this approach helps frame the issue so that it can be solved with the people and

resources involved. Furthermore, the co-design of the research and co-development of strategies and products *"allows for trustful relationships to build so that solutions developed by the research program have ownership by all partners, enhancing the implementation of solutions."* (Dennison, 2017).

Here's an example of how the different research approaches face diverse types of problems (Figure 6).

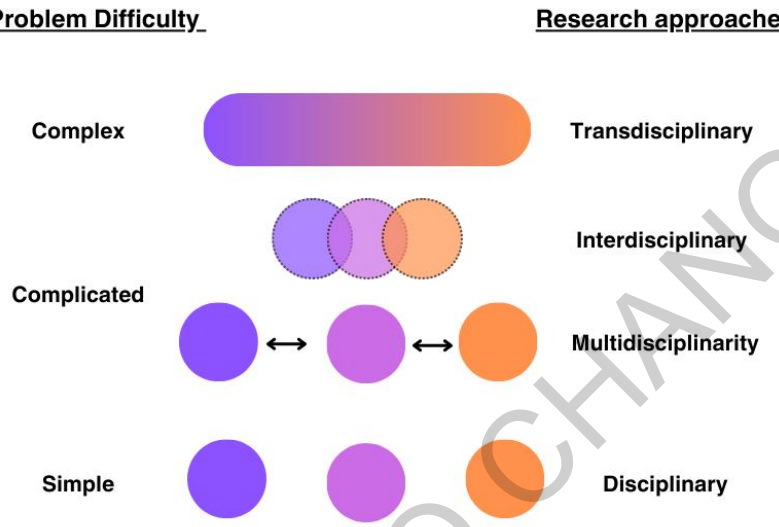

Figure 6: Degree of difficulty of the problem to tackle in relationship with the approach to be applied.

Source: Generated by the authors, based on Transdisciplinary literacy: Seven principles that help define transdisciplinary research

2) Transdisciplinary research is place based.

This dimension refers to the importance of setting issues in a place. In this *regard "societal problems which involve human perceptions and behaviors have a geography associated with them, and this geography defines the relevant stakeholders."* (Dennison, 2017). Therefore, the development of a shared problem literacy is a must, for instance, environmental literacy.

3) Transdisciplinary research is time intensive.

Executing a transdisciplinary approach is time consuming, since engaging with a wide range of partners requires time. Also, it is important to consider that trust-based relationships need to be developed and face-to-face interactions are a must, regardless of the virtual communications options available. All the steps involved take time. Furthermore, these need to be implemented continuously, instead of simultaneously. As many complex problems have taken quite a long time to be formulated, most likely their solutions will do too.

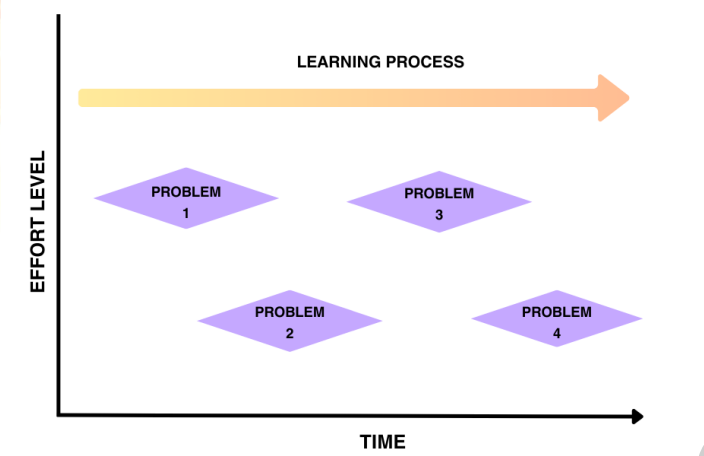

Figure 7: Relationship between the level of efforts needed with time within the learning process.

Source: Generated by the authors, based on Transdisciplinary literacy: Seven principles that help define transdisciplinary research

4) The term 'transdisciplinary' relates more to academia than to research partners (sometimes called stakeholders).

The term transdisciplinary is closely related to the academic world. In this regard, the Greeks formulated terminology that helps framing transdisciplinary approaches. Specially, the words “praxis” and “phronesis” represent key concepts. For instance, “praxis” refers to thoughtful and practical doing, which is commonly used by transdisciplinary researchers. On the other hand, “phronesis” understood as practical wisdom, is what is being sought in this approach. People outside academia mostly focus on problem solving and are mostly unfamiliar with the term “transdisciplinary.”

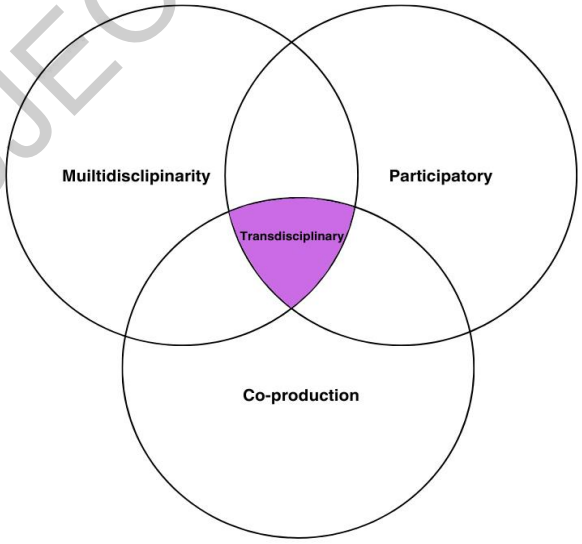

Figure 8: Transdisciplinary realm within participatory, co-production and multidisciplinary approaches.

Source: Generated by the authors, based on Transdisciplinary literacy: Seven principles that help define transdisciplinary research.

5) Transdisciplinary research requires well developed leadership skills.

A set of qualities such as inclusiveness, communication and empathy are a must in order to work with actors coming from different knowledge areas. These skills are sometimes referred to as “soft skills” and these are commonly employed in social sciences rather than “hard skills” related to physical and natural sciences. It is imperative that researchers possess these qualities, otherwise it may cause stakeholders to become disenchanted and, therefore, abandon the partnership, even to the point of becoming more unlikely to be involved in future problem-solving. Developing soft skills takes time and it is recommended to participate in other projects of this nature, before becoming the principal researcher.

Figure 9: Interpersonal skills to effectively develop transdisciplinary research.

Source: Generated by the authors, based on Transdisciplinary literacy: Seven principles that help define transdisciplinary research

6) Transdisciplinary research is intensely collaborative.

Transdisciplinary research is collaborative. *“The intensity of the collaborations is the outcome of the consensus needed for co-design, co-development and co-creation of knowledge that requires productive working relationships.”* (Dennison, 2017). In this sense, collaboration needs to emerge across scientific disciplines, but also within academic disciplines and practitioner knowledge. For instance, anthropology and ecology, but also, engineering, and indigenous knowledge. Collaborating with agents with different disciplinary languages, knowledge systems, and different values represents a challenge, intensifying the investment in the collaboration.

7) Transdisciplinary research merges multiple knowledge streams and different value systems to create new knowledge.

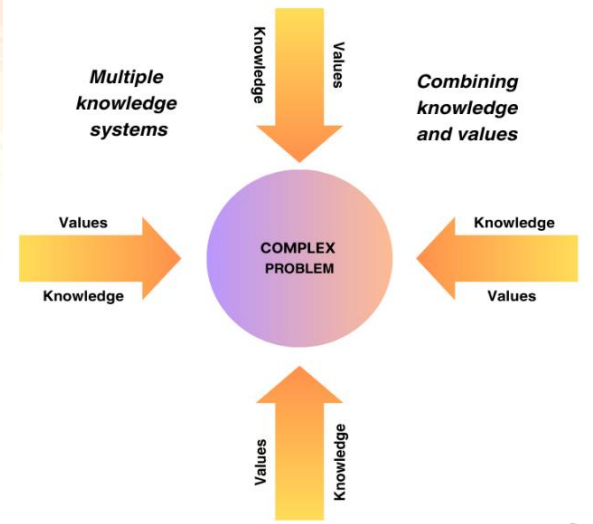

Figure 10: How multiple knowledges and values interact and combine to address a complex problem.

Source: Generated by the authors, based on Transdisciplinary literacy: Seven principles that help define transdisciplinary research

Transdisciplinary is the best suited approach to address and solve societal problems by combining different knowledge streams. However, validating the inputs of different perspectives that provide diverse knowledge flows is essential for the merging of these knowledge sources. The integration of diverse types of knowledge is quite challenging, but when it happens, it creates powerful new knowledge.

To summarize, it can be said that the discussion regarding transdisciplinary and their contributions has been around for a while. Consequently, several authors have highlighted the strengths that this approach can provide to the research field, especially when analyzing complex social, environmental, and political matters.

However, how can transdisciplinary approaches enhance sustainability research?

Jacobi et al., (2022, p.108) explains that *"Utilization of research knowledge for sustainability transformations cannot be achieved without employing a transdisciplinary approach that brings together academic and non-academic actors in a setting that enables discussions on an even footing and the empowerment of actors who are not often heard."*

It should be noted that transdisciplinary approaches can be an excellent way to address quite tricky issues within the sustainability research field due to its capacity to reinforce collaborations between agents from different backgrounds. Yet, it could also be challenging since the nature of these problems are usually interconnected. For example, governance, environmental and urban studies, among others which cannot be studied from a unique perspective.

Furthermore, it also advocates for the participation of non-academic agents and highlights the value of their knowledge and contributions to the research process. But, most importantly, it seeks the empowerment of actors that are not often involved in this type of process and promotes a horizontal hierarchy of knowledge.

Nonetheless, there are some challenges that should be contemplated within the co-creation process. For example, it should be extensively discussed and detailed the role of every stakeholder involved in the research project. In this regard, Mauser et al., (2013, p.429) explains that "*different actors will have different levels and forms of involvement in different parts of the process. This requires clarity about roles and responsibilities, about who makes decisions when, and about how to appropriately safeguard scientific integrity and relevant standards of quality."*

Another matter that should be pointed out is the need to avoid power imbalances and the replication of power structures. Consequently, Mauser et al., (2013, p. 429) highlights that *"in terms of access to power and resources, as well as research capacities, the world of science is plagued by persistent inequalities that pose a fundamental challenge to the deeper levels of collaboration that integration calls for."* Therefore, Llanque et al., (2023, p.107) express that it is extremely beneficial to "*give credit and weight to a diversity expertise."* And *"enabling diversity and inclusivity in research teams"* in order to *"decolonize sustainability research."* and to address these challenges in this research field. Although, it is required the participation of researchers, scholars, and academic agents, as well as, policymakers, it is extremely prominent to include the active participation of actors from diverse backgrounds and expertise. Also, the information generated by the discussion involving these types of agents will be richer and more extensive. Therefore, it will benefit the outcomes of the research project.

2.2 Transdisciplinarity and co-creation. What it entangles in SOLO?

There is a wide variety of literature regarding the knowledge production processes. There are several authors that make no distinction when it comes transdisciplinary and co-creation. Additionally, co-creation is not a unified term, and it can include or complement other phases such as co-design, co-implementation, and co-evaluation.

For the purposes of the SOLO project the following definitions will be used differentiating by each stage of the process. It means we can separate co-design, co-implementation, and co-dissemination as part of the co-creation process in a transdisciplinary manner.

Concisely, some definitions for each step:

a) *"During the co-design phase stakeholders and academic participants work in a coordinated, integrated way to best establish a common understanding of the research goals, to identify the relevant disciplines, participants and the scientific integration steps necessary to approach the topic, and to agree on the roles the different groups have in advancing towards the research goals"* (Mauser et al., 2013).

b) The following stage concerns the co-production of knowledge. In this sese, the authors described it as the step where *"the transdisciplinary focus is on scientific integration. During this phase integrated research is conducted as a continuous exchange among the participating scientists and with the stakeholders".* It is also mentioned that *"scientific integration also ensures that the necessary disciplinary research questions are derived from the overall needs of the project and then researched by the respective discipline, and that the scientific quality is maintained in the research process."*

c) And finally, the last one is dedicated to *the "co-dissemination of the results among the different societal groups. This includes publication of the acquired knowledge also in accessible language, translation of the results into comprehensible and usable information*

for the different stakeholders, and an open discussion on the valuation, applicability, and relevance of the results among groups of conflicting interests." (Mauser et al., 2013).

In SOLO project we identify the stages of the co-creation process based on the previous dimensions of transdisciplinary research described by Mauser et al., (2013). We also include a monitoring/evaluating process of the engagement developed to stay tuned and be flexible as required meanwhile the project is evolving. This is especially important, not only because it allow as to better follow the process and narrow the outputs and results within these complex matters of R&I in Soils in Europe, but also due to its adaptation with the Soil Mission requirements that may arise during the project lifespan.

For the co-design phase, the Think Tanks, conceptualized as group of key people gathering among one soil mission objective, will share a common overview of what we/they understand by the objective, and how research questions will be approached and highlighted. It is important to emphasize that these groups consist of members from different spheres, from civil society organizations to scientists from both natural and social sciences.

In the following step, which is reserved for co-production activities, the Think Thanks will co-develop and make suggestions for action for the future research and novel avenues in soils in Europe through the construction of 11 roadmaps (one per objective) and an overarching one.

The last phase is dedicated to co-dissemination and in this project, it will conclude with the creation of an online platform that will present all the information gathered and discussed among all actors and during the implementation of this study. Therefore, the stages will be divided as follows in Table 1.

Table 1: Co-creation phases in SOLO project. Adapted from Mauser et al 2013.

Co-creation process	(Mauser et a., 2013)	SOLO Project
Co-design	Joint framing Research design Implementation	Common overview Identify key stakeholders (KS) KS comments on the overview
Co-production	Scientific integration Relevance	Draft.v1 KS comments on Draft.v1 TT specific workshop Regional Nodes
Co-dissemination / co-Evaluation	Communication of the results	SOLO project platform Reflexive process embedded in the project

Within this research we understand engagement as *"the active involvement and participation of others in some aspect of a research project."* (Durham et al., 2014, p.11). Nevertheless, there are several levels of engagement depending on the researcher's purpose, the interest, and the influence of the stakeholders, these are: inform, consult, involve, and collaborate. In this sense, the less intensive type of engagement is called "inform" and it consists in sharing information about the project and delivering outcomes. The middle levels of engagement refer to "consultation" and "involvement". The first one is designed to meet stakeholders' needs. The latter involves a higher level of engagement since partners may provide resources or data. However,

the highest level of all four is “collaboration”, where stakeholders are effectively partners with the research team guiding the project. The following table explains the previous statement. For example, it is possible to visualize stakeholder influence against interest. In this sense, partners are situated in a certain category according to the type of contribution and intertest within the research project.

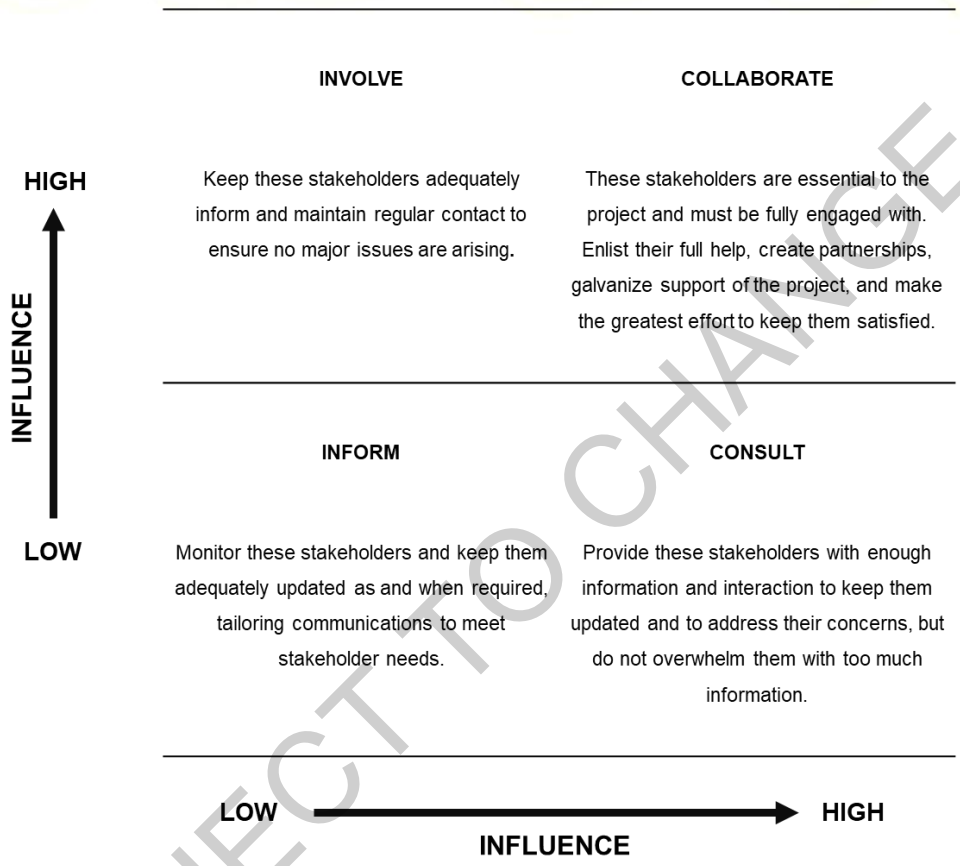

Figure 11: Engagement levels defined in terms of degree of interest and influence.

Source: Generated by the authors, based on The BiodivERsA Stakeholder Engagement Handbook by Durham E., Baker H., Smith M., Moore E. & Morgan V. (2014).

Within SOLO we aim to have the highest level of engagement, which is collaboration, notwithstanding the use of involvement or consult when may suit, but we initially target where the influence and the interest of the stakeholders are evenly high. Thus, we encourage large-scale dialogue, open deliberation and our ultimate objective is to consensually cooperate to define the future research avenues.

For that purpose of engagement and co-creation activities, the initial definition of ‘why’, ‘who’, ‘when’ ‘what’ ‘where’ and ‘how’ (5W+H model) to engage has been discussed by the partners in the first consortium meeting and consequent meetings, concluding in the structure and functioning of the Think Tanks (see the next section 3, and specially subsection 3.2). We highlight the main elements, requirements and challenges behind the desired societal engagement related to the 5w+H model. Those elements described in Table 2 are a summary of the TT key aspects determined in the following section.

Table 2: Key aspects, requirements, and challenges of societal engagement. Adapted from Bauer et al 2021

Main question	Key aspects to consider	Requirements	Challenges and open questions
Why	Purpose	Substantively improving R&I decisions Embedding of societal engagement in R&I governance	Lack of tangible influence Missing links to decision-making
Who	Actors	Inclusiveness Balanced representation Balanced view	Legitimacy Lack of willingness, capacities and capabilities to participate Individual, organisational and societal experiences with engagement
When	Timing	Upstream engagement Continuous engagement	Lack of debate, interests, knowledge Institutionalisation of engagement
How	Procedure	Two-way communication Organised engagement	Expert takeover Systematic scepticism Integration of bottom-up initiatives
What	Framing	Ethics and societal needs, values, concerns Openness	Agenda-setting Narrow versus broad framing Consensus versus dissent

3 SOLO Think Tanks in practice (the guidelines)

3.1 What is a key stakeholder in SOLO?

A stakeholder is any person or group directly or indirectly affected by a project, as well as those who may have interests in a project and/or the ability to influence its outcome, either positively or negatively.

Stakeholders generally come from different fields. For example, relevant groups can be policy makers, scientists, citizens, among others. However, it should be noted that individuals within the same group do not necessarily share the same interests and motivations.

In Soils for Europe Project a key stakeholder is someone that belongs to one of the identified groups of interest for the project (policy makers, civil society, practitioners, industry agents and scientists), but is also a member of one of the eight Think Tanks. Concretely, these key stakeholders:

a) shouldn't be present at more than TT, if this situation occurs, they must decide on which one will be involved,

b) they should comment on the overview and Draft.v1 at each phase. Think Tank leaders will be the ones in charge of this process with the aid of T2.1 partners,

c) will be encouraged to participate in the workshops,

d) they can be co-authors. It is important that the TT leaders highlight that to them, as the efforts have a direct result, apart from the knowledge shared/transferred,

e) the distribution must meet the following requirements: maximum 50% of the stakeholders contacted should be soil scientist, maximum 70% of the stakeholders contacted should be scientist,

f) the range of stakeholders to be involved ideally will cover these five groups (previously mentioned)

3.1.1 Why is stakeholder engagement beneficial? And why should it benefit the stakeholders?

One of the primary benefits of stakeholder engagement is the creation of links between science and society, providing access to additional information or resources, and improving the relevance or utility of the research to users and beneficiaries. Concretely, through engagement, the project's result can be tailored to local contexts, increase the possibility that the outcomes are applied, and therefore, have a positive impact.

Another important aspect to highlight is that well-managed engagement can drive learning and trust among the members and help reconcile any issues that might emerge. Lastly, it can enrich research and provide better knowledge.

In this line, there are several interesting features that should be emphasized within this project. For instance, one of its key attributes is the tangible outcome with high impact level that would originate from it. In other words, stakeholders can consensually determine the future research lines for soils in Europe. We strongly believe that this will encourage and enhance the commitment of said stakeholders during the implementation of this project.

Also, an investigation of this nature *"can trigger an intense learning process. It can empower and motivate stakeholders to contribute more actively to the implementation of related decision processes"* (Lang et al., 2012, p.29). In this sense, through the application of the online and face-to-face reunions and activities information will be exchanged and therefore, it will allow participants to hear different opinions and issues, which will provide a broader view on this matter. Having a space through the implementation of the participatory activities, where participants can freely share their thoughts and ideas which might lead to an open deliberative discussion. But most importantly, having a space where they learn from one another making SOLO unique.

3.1.2 Challenges and limits of the engagement

There are several aspects to consider so that complications and issues can be avoided when engaging. The first one refers to the incensement of the cost of the project and the stakeholders in the short run. In contrast to the research outcomes that might seem intangible and remote. This might discourage stakeholders from participating. Furthermore, the lack of experience and time to engage might lead to "stakeholder fatigue", and therefore, it may affect the willingness and the quality of the stakeholders' implication within the project. (Durham et al., 2014). Lastly, it is important to create a balance among stakeholders to avoid the reinforcement of privileged dynamic structures.

3.1.3 Key points for engagement

Another key aspect to contemplate is the methods employed for engagement. These will depend on the objectives, the level of engagement, the timing of when engagement activities are intended to take place, and the expected role of the stakeholders**.** (Durham et al., 2014). As with any other procedure, all engagement methods experience strengths and weaknesses. Hence, it is essential to select the best match for the context, purpose, the needs, capacity, and expectations of relevant partners.

Engagement methods can be of different nature: participatory (two-way) and informative (one-way). The latter is considered for engagement if they are designed with the stakeholders in mind, and if their needs are met. On the other hand, there are available a wide variety of techniques to ease effective two-way engagement, such as: opening out, integrating, exploring, and deciding.

Table 3: Definitions of the key phases that should be included for an effective two-way engagement process.

OPENING OUT Implemented for opening dialogue and gathering information with stakeholders. It is mostly applied during the initial phase of the project and the development of initial research questions prior to writing a proposal, or in the early stages of a funded project.	**EXPLORING** Facilitates the evaluation and analysis on preliminary findings with stakeholders. Getting early feedback on preliminary discoveries can help keep stakeholders interested and therefore, give them greater ownership over the research outcomes.
INTEGRATING Applied for exploring, analyzing and deciding and it can be implemented during the entire research process.	**DECIDING** Refers to the fact of deciding actions based on research findings. There are several techniques that address engagement between researchers and stakeholders in decisions. For instance, prioritizing particularly interesting or relevant findings for further research or actions.

Source: Generated by the authors, based on The BiodivERsA Stakeholder Engagement Handbook by Durham E., Baker H., Smith M., Moore E. & Morgan V. (2014).

3.1.4 TT structure

During the first year, we will concentrate our efforts in what is divided into 3 phases for the first year of the project (Figure 12). Each phase coincides with a Tier, that is the level of engagement desired (Figure 12 and 13). Then the first phase is developed by the TT leaders and the WP2 partners (Tier 1), the second one adds the ideally ~20 key stakeholders for each TT (Tier 2), and the third one, at the end of the year opens the discussion to the wide public with the platform (Tier 3). How we conceptualize the tiers is described below in Figure 14.

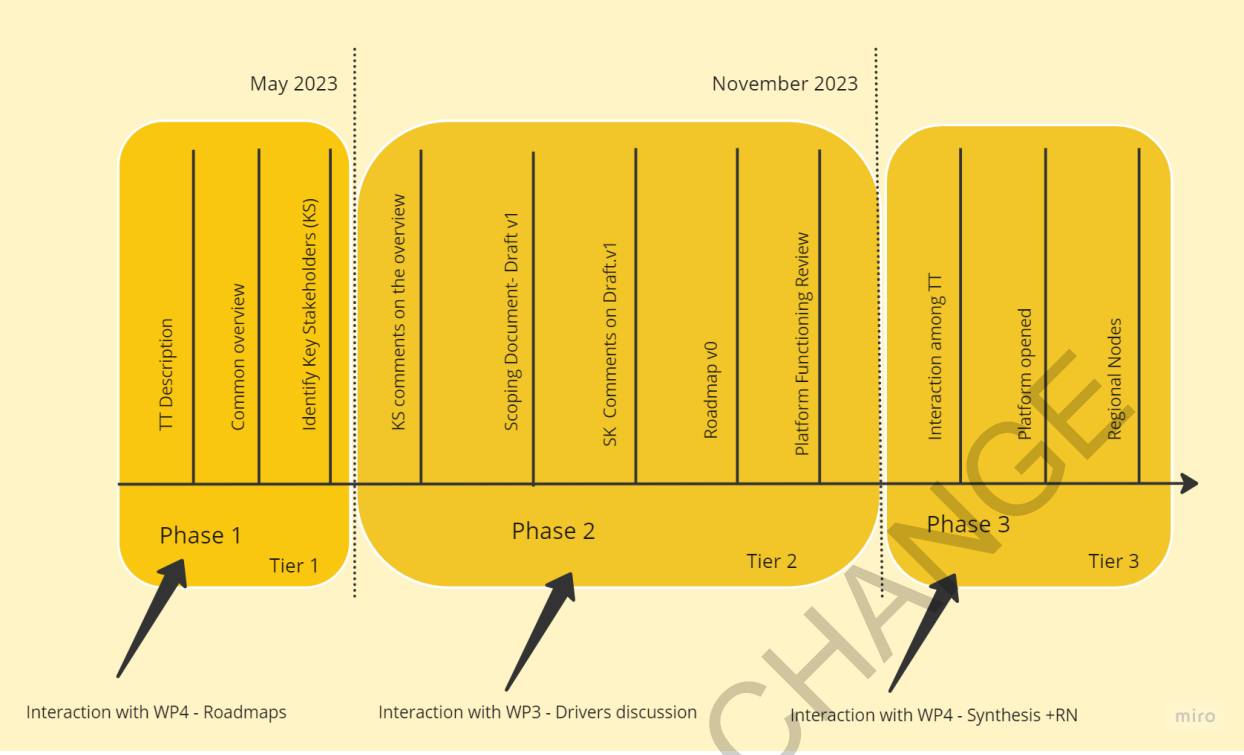

Figure 12: Description of the activities at the 3 initial phases of the SOLO project

1. Phase 1 / Tier 1
   - Each TT develops its own draft: The **overview** ~1-2 pages (Appendix 1)
   - We share among the TT leaders and SC the overview and comment on that
   - Each TT contacts their own key stakeholders

2. Phase 2 / Tier 2
   - The TT contacts comment on the initial draft (the overview)
   - The draft evolves to a version which includes the comments and where the state of the art is deeper, and the GAPs increase. **Draft.v1.**
   - Each TT needs to implement a workshop, being virtual or presential
   - The SOLO partners will test the Platform functioning
   - The members of the SNoK (Key stakeholders + TT leaders) comment on the Draft.v1.

3. Phase 3/Tier 3
   - The interaction between the 10 TTs plus their key stakeholders will take place
   - The platform will be opened and the Draft.v1 will be included there to be commented by anyone.
   - The interaction with the Regional Nodes will start.

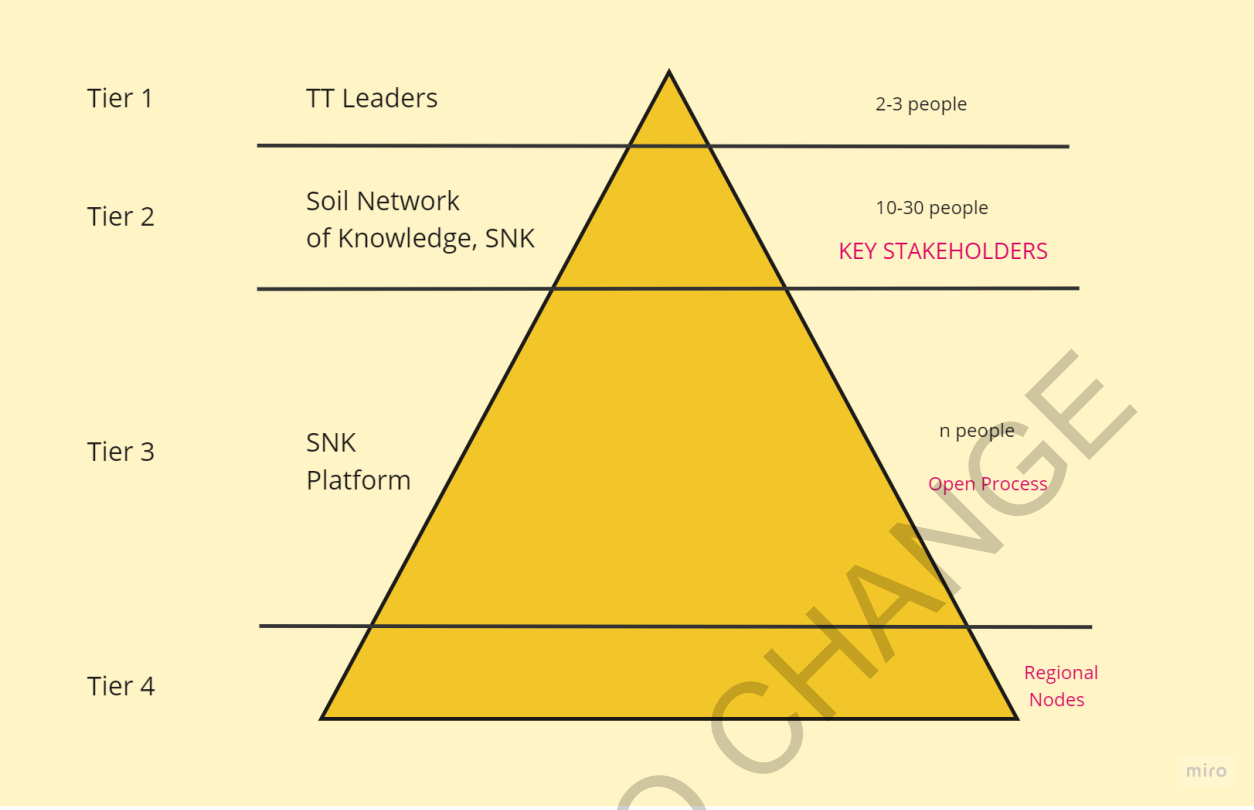

Figure 13: Pyramid of involvement in the Think Tanks for the different stakeholders.

Then, 11 roadmaps (one per Think Tank) will be delivered at the end of 2023. The TT roadmaps are considered a process by themselves and the backbone of SOLO project. The interaction among them and other elements of the project is defined by WP2, and this document as illustrate in Figure 16.

All the 11 roadmaps will start with a common structure, defined in section 4. The TT roadmaps will be populated by the research gaps and state of the art predefined per Think Tank and discussed in a joint meeting where overloads and interactions among them will also be tacked.

Figure 14: Think Tanks, their two-ways interaction with the different element of the project (the network of knowledge, soil health drivers, regional roadmaps and KPIs) and the main outputs to deliver yearly to the soil mission.

After the first year of the project (illustrated in Figure 15) at the end of 2023, a similar procedure will follow where the main difference is the starting point. The initial synthesis will be made, and the results will be the ones starting over with the Figure 14 to 17 illustrated procedure. Parallel, when results from the Regional Nodes roadmaps will be described and populated, they will be included into the synthesis and its roadmaps will mirror and be mirrored by the TT roadmaps, interacting among them. This cyclical procedure will be repeating till the end of SOLO in 2027.

Figure 15: Iterative process in SOLO lifespan. Every year the Think Tanks will repeat the same process, be nourished by the year before and nourish the incoming year.

3.2 TT template for the initial Scoping Document

As a guide for the TT leaders, and with the aim of giving certain degree of homogeneity to key points to start the co-creative processes within each TT, a template has been provided. It was made by the requirement of the TT leaders and an initial draft was shared and discussed first. After that joint discussion the changes were made accordingly and a template for the TT scoping documents is provided in Appendix 2.

The **Scoping document** should:

- Answer the question: Why do we still need research on this TT particular topic? In what would this research focus on?
- Include a State of the Art
- Include a Gap analysis
- Include a prioritization of the GAPs

It will be complementary with the roadmap that each TT will produce (further described in section 4), and in accordance with the overall TDR methodology and engagement strategy in SOLO (from co-design to evaluation). Further descriptions of the scoping document are described in section 5 (Solo Network Knowledge).

4 Roadmaps and the TT. From conceptualization to practice

The results from each Think Thank (TT) will be integrated in WP4. The integration will take place across Mission objectives to develop an overarching roadmap consisting of the assessment of the synergies and trade-offs between the Mission Objective roadmaps from T2.2 and regions (T4.4). To achieve this, we will develop a matrix to identify potential conflicts and opportunities across the different Mission Objectives and regions.

For the integration, it is essential to develop a common structure for a roadmap that will be applied to the preliminary roadmaps of each TT. The integrated roadmap should encompass the following results of each TT:

i) Preliminary assessment of knowledge gaps and novel avenues for soil health research and innovation in Europe, including priorities and a timeline. This assessment will identify areas where further research and innovation are needed to enhance soil health in Europe, prioritize them based on their importance, and provide a timeline for their implementation.

ii) Identification of novel technical and technological developments that can contribute to the implementation of the Soil Mission objective. This step involves identifying new and innovative approaches, tools, and technologies that can be utilized to achieve the objectives of the Soil Mission, such as improving soil health, soil management practices, or data collection and analysis methods.

iii) Identification of major bottlenecks and risks for the implementation of the Soil Mission and the fulfilment of its specific and operational objectives. This involves identifying potential obstacles, challenges, and risks that could hinder the successful implementation of the Soil Mission. By identifying these bottlenecks, appropriate strategies can be developed to overcome them and ensure the smooth progress of the Mission. Here is the close cooperation with the WP3 required.

iv) Identification of legislative and institutional barriers that might hinder the impact of the Mission's research and innovation activities. This step involves identifying existing regulations, policies, or institutional frameworks that may impede the effective implementation of the research and innovation activities associated with the Soil Mission. By addressing these barriers, the impact of the Mission can be maximized. Also here are the linkages with the WP3.

v) Definition of key performance indicators (KPIs) to monitor the achievement of the research and innovation priorities defined in the Soil Mission. This includes establishing measurable indicators that will be used to assess the progress and success of the Soil Mission. These KPIs will enable monitoring and evaluation of the implemented actions, ensuring that the defined research and innovation priorities are being effectively addressed and accomplished. Here is the close exchange with the WP5 required.

By following this comprehensive structure for the roadmap, the TT can effectively contribute to the integration and advancement of the Soil Mission, ensuring coordinated efforts and a systematic approach towards improving soil health and achieving the mission's objectives.

The roadmaps will be produced at three levels:

1. Overarching Roadmap (SOLO main output)
2. One road map per Think Tank
3. Roadmaps for the Regional Nodes

4.1 **Roadmapping in brief**

Roadmapping is a pragmatic and universally applicable tool for supporting and preparing the planning and forecasting of future developments, whether on a technology, product, or market level. Unlike most operational planning tools, roadmapping does not originate from scientific theory but was first developed and used by large companies in technology-intensive industries. All roadmaps have a future orientation, a temporal connection of the aspects presented, and work towards a vision or goal. Thus, a roadmap illustrates developments and events as well as their connections over time. This helps to detect inconsistencies early on: technological inconsistencies (lack of knowledge of developments), market inconsistencies (lack of knowledge of developments and requirements), and organizational inconsistencies (lack of coordination and communication).

The roadmaps examples considered had very different backgrounds, overarching goals, and specific purposes. Policy roadmaps might be used for program design (e.g., Health Roadmap), to provide an overview of other future studies and roadmaps (e.g., Meta-Roadmap Nanomaterials), or to be used for further program or project design (e.g., InnoRegio Innosachs Project Roadmap). Most roadmaps explored future development in specific fields or areas (e.g., Minimally Invasive Brain Surgery, Environmental Technologies 2020, Zero-Acreage Farming, Technology Integration in Personal Services, Lithium-Ion Batteries 2030, etc.). There were also overarching roadmaps provided to present an overview of a specific field up to a certain point in time (e.g., Ambient Intelligence 2020, Nordic Hydrogen Energy 2030, Roadmap High-Performance Ceramics 2025, or the NanoRoadMap).

Almost all roadmap projects aim to provide their country, region, association, or company with a competitive advantage through better-bundled knowledge of future developments. Roadmaps aim at coordinating the different countries and stakeholders and identify commonalities to develop a joint strategy. They might also serve to further elaboration and illustration of the goals set in national or European plans.

Some types of roadmaps are:

- Technology roadmaps: Aim to establish a linkage between market demand and the firm's technological ability
- Product roadmaps: Addresses conditions and requirements that need to be met to make a new product ready for the market
- Industry and sector roadmaps: Deal with the question how the firms of an industry branch/sector can contribute to the development of the sector
- Project or thematic roadmaps: Focus on specific topics
- Technology Application Roadmaps: Aim to establish a well-grounded linkage between research and application in order to assess a technology's implications for society.

Below, we will provide an example of a very specific roadmap to illustrate what sort of inputs WP4 needs from WP2 in order to develop the road maps in SOLO.

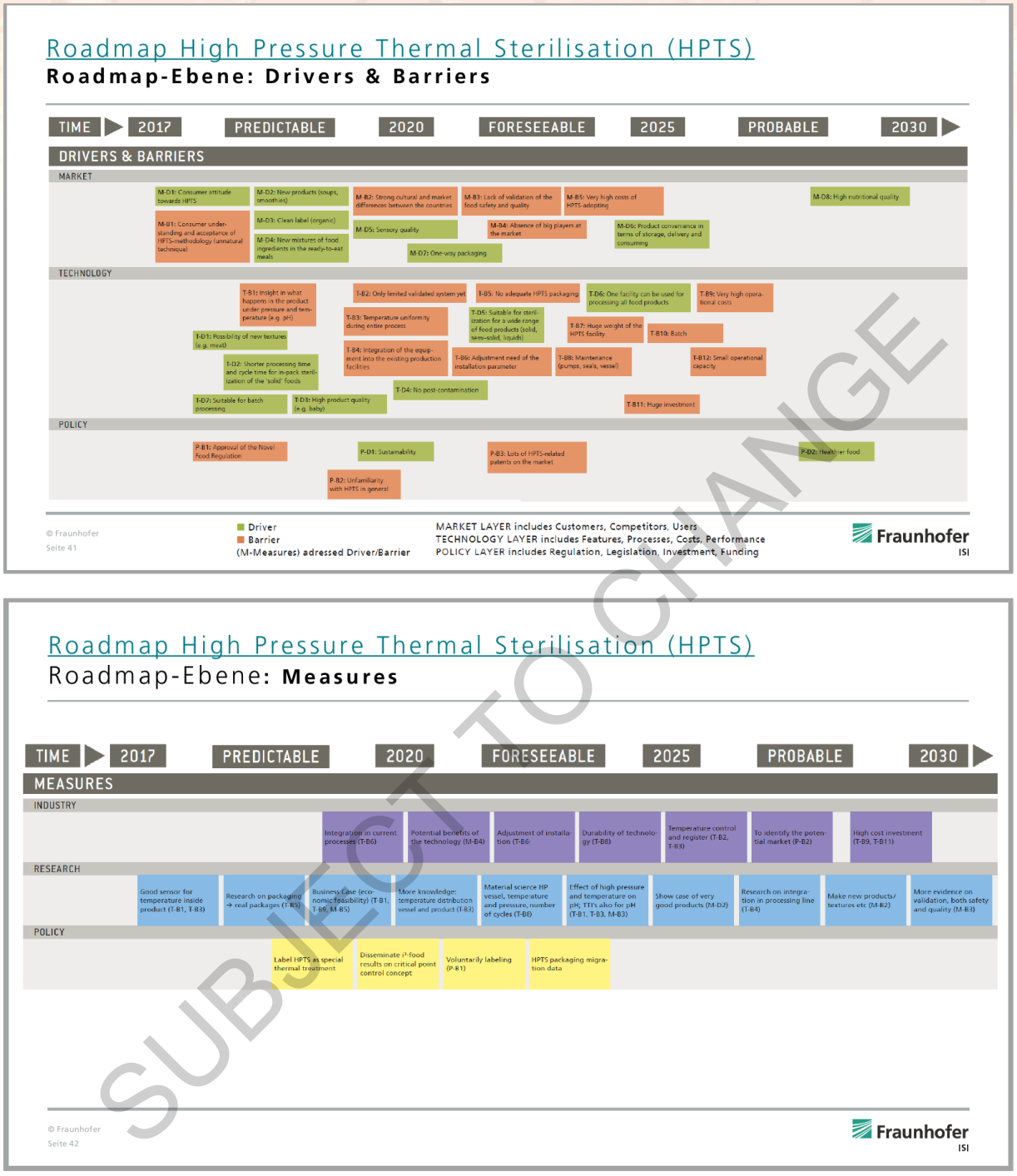

Figure 16: An example for a roadmap with focus on drivers and barriers for emerging food technologies

Source: ***https://publica.fraunhofer.de/eprints/urn_nbn_de_0011-n-4812767.pdf***

4.2 Roadmapping in the SOLO project

On May the 9th WP4 joined the WP2 TT meeting to explain, discuss, and get feedback from the TT about the type of information needed to start developing roadmaps. During this workshop, two main topics were covered:

The first topic focused on providing input regarding the methodology, procedures, types, and examples of roadmaps. The basic idea of a roadmap was discussed, which revolves around the question of how to achieve our goals. Roadmaps are visual representations that illustrate the relationships between developments and events along a timeline. Roadmaps serve as a means to answer several key questions:

- Where are we now? This refers to the present situation or the current state of affairs.
- Where do we want to go? This encompasses the vision or desired future scenarios.
- How can we get there? This involves identifying the necessary developments and measures to reach the desired goals.
- Why do we have to act? This considers the internal and external trends and drivers that necessitate action.
- What has to be done? This entails determining the required products, services, procedures, and measures.
- How should we manage it? This addresses the allocation of resources, utilization of technologies, and involvement of relevant stakeholders.
- What should be done and when? This establishes the time horizon and sequencing of actions.

The workshop included detailed presentations of project examples of Fraunhofer ISI, showcasing scenario-based roadmapping and regional strategy roadmapping. Furthermore, a roadmap development approach was outlined in five steps, demonstrated using a specific example:

- Target setting and system definition.
- Analysis and forecast of trends and external requirements.
- Analysis and forecast of potentials.
- Stepwise completion of the roadmap.
- Analysis of completeness and consistency.

The second topic of the workshop was brain writing and discussion, which involved generating initial ideas for building TT roadmaps. Participants utilized the Miro board, an online collaboration platform, to share their thoughts and insights. The discussion focused on various elements, levels, and timing considerations for roadmap construction. Eight examples of roadmaps were presented, each highlighting different key aspects, including:

- Vision, measures, and impacts: Living Labs for a Green Economy 2030
  https://www.isi.fraunhofer.de/de/competence-center/foresight/meldungen/2018/Innolab-Roadmaps.html /
  https://www.isi.fraunhofer.de/content/dam/isi/dokumente/ccv/2018/2018-02_Erdmann_Geibler_et_al_Roadmap_Living_Labs_lang.pdf
- Vision and measures: The LivingRAIL Railmap 2050
  https://www.isi.fraunhofer.de/de/competence-center/nachhaltigkeit-infrastruktursysteme/projekte/livingrail.html#4 /
  https://cordis.europa.eu/project/id/314036/results/de

- Fields of action and measures: Innovation and Research Südtirol 2030 https://www.isi.fraunhofer.de/de/competence-center/foresight/projekte/suedtirol2030.html#1 / https://www.provinz.bz.it/innovation-forschung/innovation-forschung-universitaet/downloads/Innovation_und_Forschung_Suedtirol_2030_RIS3.pdf
- Milestones, policies, and activities: UK Government 2021: Hydrogen Strategy https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1011283/UK-Hydrogen-Strategy_web.pdf
- Research and innovation (R&I) activities and investments: ERA industrial technology roadmap for low-carbon technologies https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1011283/UK-Hydrogen-Strategy_web.pdf
- Research-based strategy: A National Roadmap for Water Stewardship in Industry https://www.epa.ie/publications/research/water/Research_Report_261.pdf
- Drivers and barriers: Roadmap High Pressure Thermal Sterilisation (HPTS) https://www.isi.fraunhofer.de/de/competence-center/foresight/projekte/i3-food---new-treatments-for-better-food.html#393989854 / https://publica.fraunhofer.de/eprints/urn_nbn_de_0011-n-4812767.pdf
- Values and impact: ESFRI Roadmap 2016 https://research-and-innovation.ec.europa.eu/system/files/2018-07/esfri_roadmap_2016_full.pdf

These examples served as inspiration and provided a basis for participants to generate ideas relevant to their own roadmap-building processes.

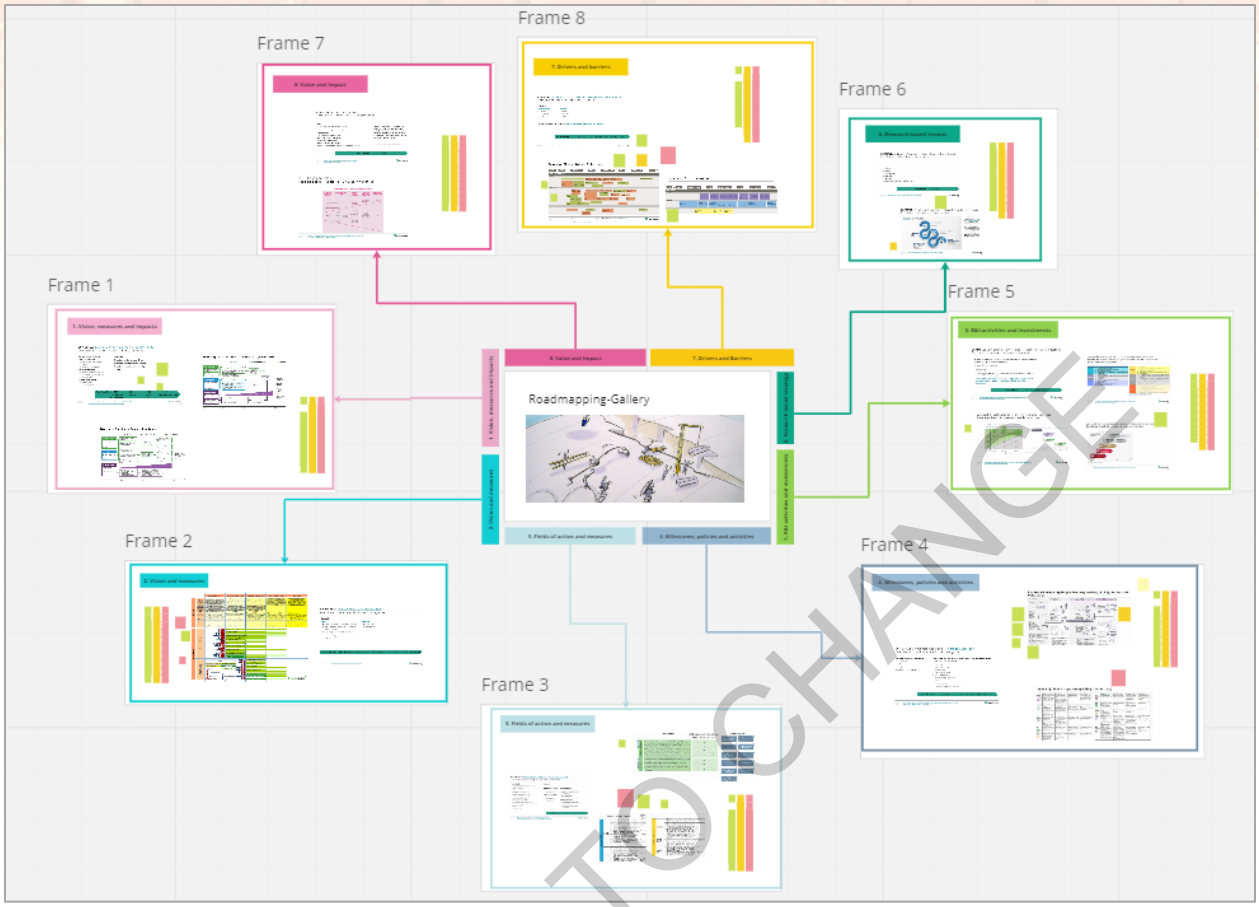

Figure 17: Project examples from different key areas

Source: Miro board Roadmapping workshop for Think Thanks

On this basis a first draft of the structure for the TT roadmap was elaborated and discussed. By addressing these two main topics, the workshop aimed to provide participants with valuable insights, methodologies, and practical examples to effectively develop roadmaps aligned with their goals and objectives.

This feedback will be processed and returned to the Think Tanks that start working on information needed for the roadmap development version 1.0. The concrete next steps are presenting the roadmap template during the SOLO General Meeting on 15th July and to the TT during the TT meeting in September.

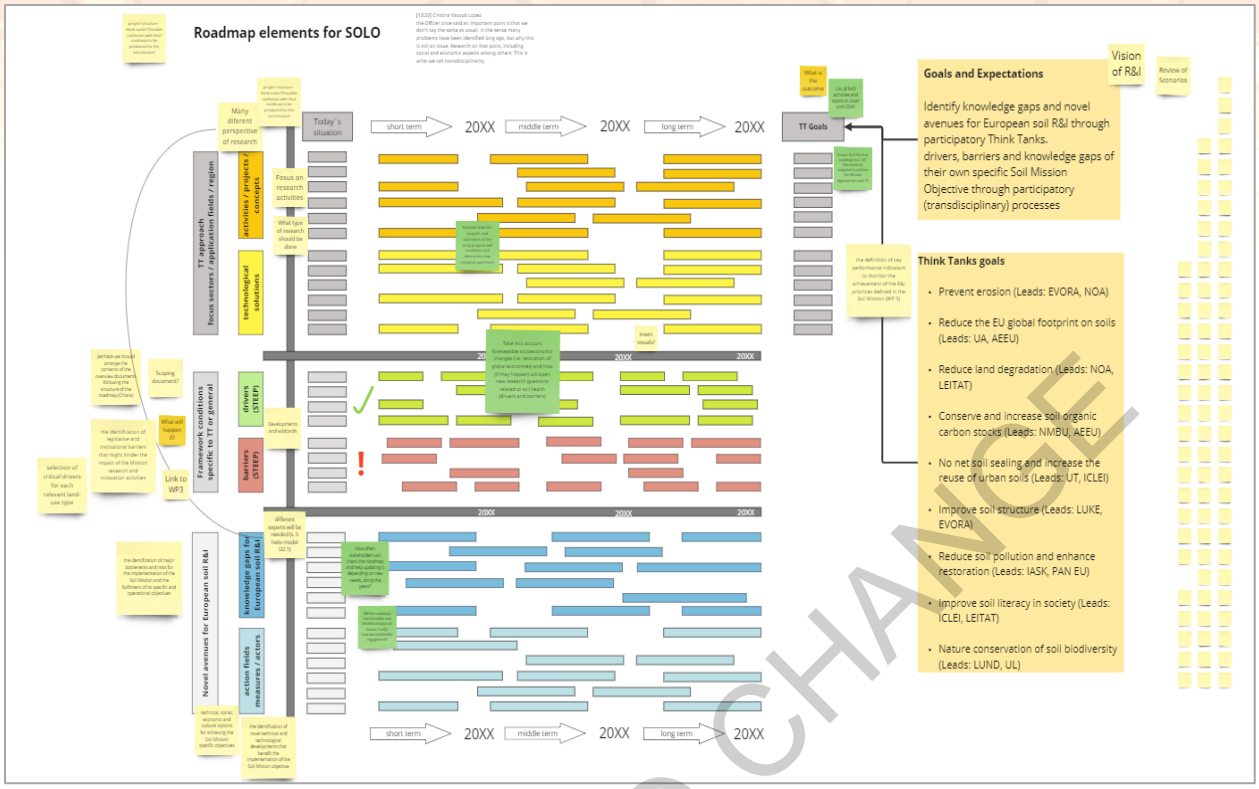

Figure 18: Discussion on elements for the SOLO Think Thanks Roadmap

Source: Miro board Roadmapping workshop for TT

In Barcelona (SOLO meeting December 2023) the first results of road map information delivered by the Think Tanks will be presented in a workshop and feedback will be generated by discussion. Thereafter, WP2 continues with an updated request to provide the more final information for the roadmap development in WP4.

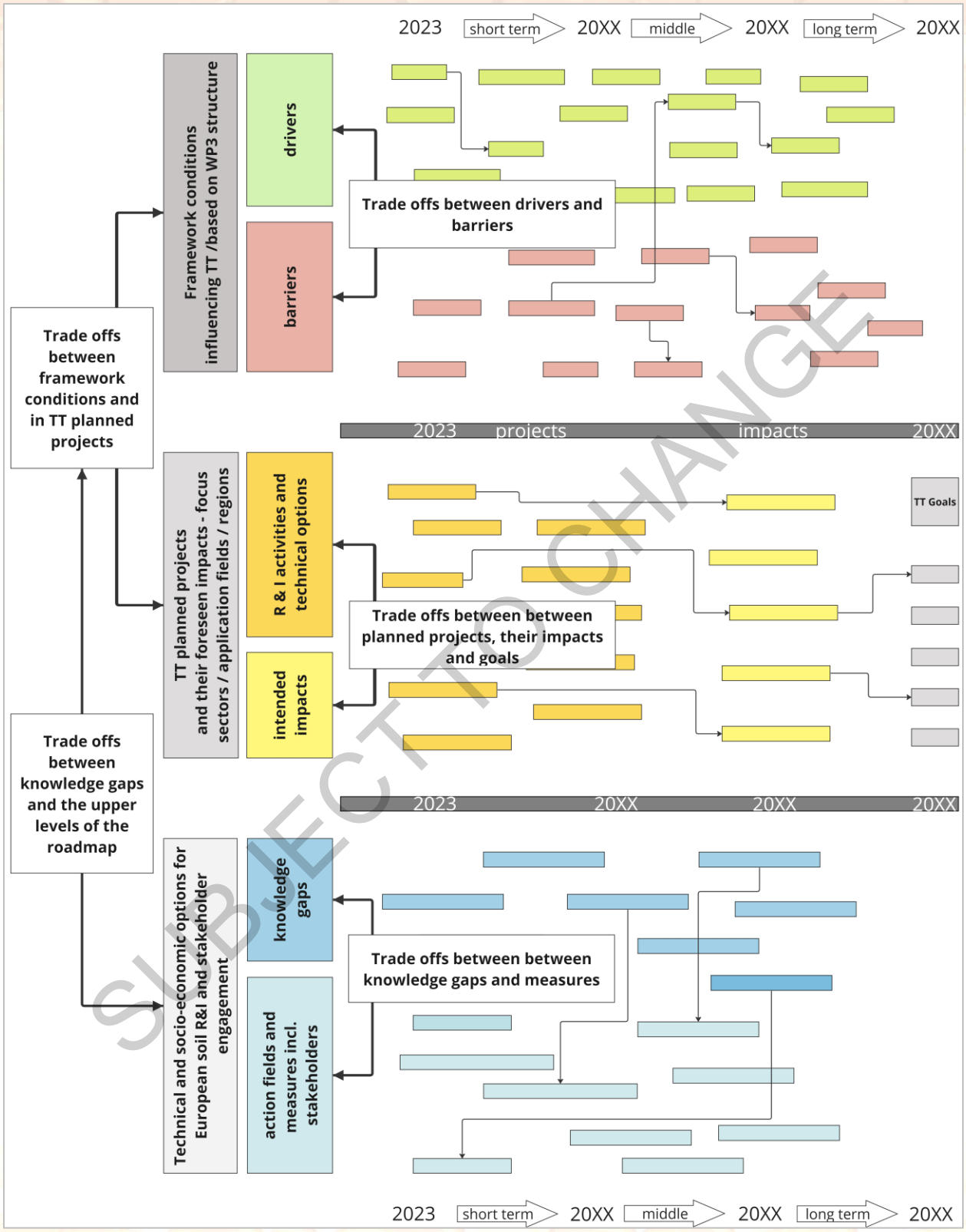

Figure 19: Draft roadmap template for the TT roadmaps

5 SOLO Network of Knowledge in practice (the strategy)

Following Phelps et al (2012) we understand knowledge networks as consisting of nodes that serve as repositories of knowledge and agents that search for, adopt, transmit and create knowledge. Importantly, the knowledge networks also consist of social relationships between nodes which constitute a means by which nodes search for information and knowledge, a medium through which information and knowledge diffuse and flow, and a lens through which nodes evaluate each other (Podolny, 2001, in Phelps et al. 2012).

Online Networks of Knowledge have proved to be relevant wells of knowledge through their capacity to garner collective intelligence, to stimulate interorganizational exposure and learning, to transform tacit knowledge into shared explicit knowledge and to simultaneously propel generative learning resulting in individual and organizational achievements (Vatamanescu 2023).

In this sense, the nonlinear and integrative function of online academic networks covers the underlying relationships among personal, organizational, and trans-organizational knowledge where individual motivation to acquire knowledge has a significant influence. Further, active engagement with a network's intangible resources leads to a significant harnessing of the three-component intellectual capital (human, structural and relational) (Vatamanescu 2023). Therefore, we understand the element of motivation key for the effective engagement embedded into the knowledge sharing process within SNK.

The **Network of Knowledge that arises in SOLO** is understood as a knowledge and innovation network of regional, national and European partners that will include members from multiple sectors including soil scientists, soil ecologists, social scientists and economists, anthropologist and psychologists, climate researchers, governance specialists, policy and lawmakers, NGOs, corporations, retailers, food quality and safety organizations, space agencies and Earth observation researchers, institutions related to impact assessment, restoration and remediation, consumer organizations, and educators.

The transdisciplinary approach and strategy of co-creation will enable to increase stakeholders' capacities and their participation within the Soil Network of Knowledge beyond the project as well as the further uptake of the project dynamic Roadmaps and Operational framework. This strategy comprises from the identification of knowledge gaps and critical novel pathways to the description of multi sectorial drivers of soil health, understanding of needs for regenerative management pathways that go beyond current path dependencies, identifying context-specific elements enabling policy and governance arrangements and the implementation of an operational framework that allows to oversee, monitor, and assess the fulfilment of the Soil Mission's objectives.

The main aim of the SNK is to identify current knowledge gaps based not only on synthesis and review of existing European research and innovation priorities connected to soil health, but also to expand them and underpin novel avenues that will form the basis for the establishment of the Soil Mission roadmaps.

Therefore, the SNK comprises the TTs co-creation processes, and all its components co-implemented there and expands beyond through an open participatory platform (developed by PENSOFT and based on ARPHA). In brief the SNK counts on:

- The TTs
- The Platform
- The Regional Nodes
- The joint efforts with other initiatives and projects
- The interaction among them all

In this section we focus on the SNK including the TTs co-creation process and beyond, meaning the expansion of the TTs and the interaction among the TTs and with other stakeholders, initiatives, and projects. First, we include the methodology to guide the review process with all the shared documents specially for the scoping document. Following some participatory strategies that we consider especially key for SOLO TTs and SNK are described. Finally, a prioritization methodology is described as a starting point to discuss how to prioritize and giving some answers to the final outputs of the project: which GAPs we'd conceive as the prioritized ones for achieving the objectives of the EU Soil Mission and have a real impact on improving soil health optimizing the potential trade-offs.

5.1 Methodology to review in SNK

This sub-section contains two methodologies as a guidance for the TTs and the SNK. On one hand, the methodology within the development and functioning of the Platform is introduced briefly. Secondly, a methodology to follow regarding possible systematic reviews is also included, and Appendix 3 contains further details.

Platform functioning

Regarding the methodology to be follow within the platform, is described in depth in Deliverable 1.6: SOLO Platform, project website and social media profiles (Mehandzhiyski N et al. 2023). Here we introduce the main insights. In brief, the easy-to use platform is composed by the following elements: a one-stop login process and outlook lists to help on the platform, document templates, collaborative authoring and editing inside or outside the project, groups of discussion, invitation to internal and external peer-review documents prior its publication, publication of the co-created document, and review of the public document (post-publication review).

Therefore, the structure of the platform will be created and populated by templates and supporting tools for discussion, sharing documents and review processes. In regards creating new documents based on the templates and editing them, it can be developed inside and outside the platform, but it is necessary incorporate it into the platform prior to its submission to benefit from the ARPHA writing tool.

The discussions groups can be presented as forums or mailing lists or an automatic alert when a document is ready to be reviewed. It needs to be discussed if it will finally be placed within the ARPHA writing tool or at the SOLO website.

Stakeholders that already agree to review a document, they can also upload a document, they need to select the topic within the platform and an automatic invitation for review (a link in an email) will be sent to all the other users assigned to a particular topic.

Invitations for review prior to be published will be made with the key stakeholders from each TT who agree to review the document and they would be able to join through a link and a registration. After a timeframe decided by the TT leaders, the pre-publication review process will be closed, and the author may submit the document. All reviewers who have submitted reviews through the system will be acknowledged through notification emails upon publication. The authors/editors will also be able to include all reviewers as authors or in the Acknowledgments section of the document depending on their involvement.
The documents may be open for further reviews after being published with other stakeholders that may be interested into it. If the TT leaders consider the review valuable, a second version of the document can be published.

As mentioned before, for each year of the project, a version of a scoping document will be created. Therefore, every year a new document will be created, to maintain the prior information to be compared with the evolved one every year.

Review process

With the objective to harmonize methods within SOLO, we propose the TTs to use a methodology described by Dicks et al. (2017) within EKLIPSE project. WP3 is using the scoping review following EKLIPSE definitions and Mak and Thomas (2022). The latter states that *"is a type of knowledge synthesis that uses a systematic and iterative approach to identify and synthesize an existing or emerging body of literature on a given topic"*. We attach a broader description of scoping review and a couple of references of interest in Appendix 3 following Dicks et al. (2017).

It also needs to be mentioned that other methodologies than the scoping review may fit better or to SOLO. Better said a combination of other knowledge synthesis methods is highly valuable. SOLO review process at different layers (with key stakeholders first and going further thought the SNK platform) and the co-creation of the roadmaps in parallel confers a strong overall methodology that covers exploratory, analytical and evaluation methods at a time engagement methods at different levels are taking place.

Following the same source (Dicks et al 2017), we also mention expert consultation as a similar method and structured decision making, focus groups, and multicriteria decision analysis as complementary in terms of capacity for engagement and risk of bias (see Appendix 3).

We consider a systematic review is too time and resources consuming to be developed into the SOLO TT, but in case the TT decides to implement a systematic review we recommend following the PRISMA 2020 statement (Page et al 2021) as a guideline for reporting systematic reviews if needed. The PRISMA 2020 statement provides updated reporting guidance for systematic reviews that reflects advances in methods to identify, select, appraise, and synthesise studies. The guideline encourages authors to prepare a transparent, complete, and accurate account of why the review was done, what they did, and what they found ensuring its value and impact. The PRISMA 2020 statement consists of a 27-item checklist, an expanded checklist that details reporting recommendations for each item, the PRISMA 2020 abstract checklist, and revised flow diagrams for original and updated reviews (Page et al 2021).

5.2 Participatory strategies in SOLO

The implementation of a transdisciplinary study implies the integration of participatory activities since as mentioned previously, this approach encourages the involvement of several actors in various stages of the process, such as the problem framing, facilitate information exchange and ultimately knowledge construction.

However, some activities will be suggested for implementation to enhance the participatory dimension in the SOLO project. Even more, it is important to ensure a high level of participation in all research stages and its duration. This represents a possible challenge regarding maintaining desirable engagement levels and motivation.

There are great variety of participatory practices that promote consultation, discussions, stakeholders' engagement, direct voting, among other virtues. However, searching for this information can be quite overwhelming as there is a significant diversity and they are classified according to their contributions and implication on the decision-making processes. Fortunately, there is an online research tool called Engage2020 Action Catalogue that provides information about a collection of 57 participatory methods, so that anyone can thoughtfully select the methodology that suits the project needs. It also allows researchers to sort them out through 32 criteria, with the possibility of weighing the importance of each criterion. In this regard, we have selected some methodologies that fit the purpose and characteristics of the SOLO project. These will be described below:

5.2.1 Deliberative online forum

This participative tool is an effective way to generate discussions about the participant's concerns about a specific topic. It is usually implemented in democratic and governmental matters, but it has also been applied in the demographic change, wellbeing, and climate action fields. In addition, since the stakeholders are based in different countries, its online nature facilitates their interaction.

Nevertheless, like many other participatory instruments, the deliberative online forums also bear some flaws, such as, the requirement of a good IT skills, and the fact that the quality of the deliberative process highly depends on having a previously adequate design, as well as the possible lack of pluralism in the process. Regardless, the first one can be avoided with the application of a well-structured platform that can enable a more organized participation.

In order to carry out this tool, we suggest considering these two options that can facilitate the application of the deliberative online forum. These platforms have been used to develop notable participatory processes in Europe and the United States, such as: Decide Madrid, Stadt Würzburg, Dijital demokrasi platformu, Participatory strategic planning by the Washington State Democrats and the Input on Climate Action Plan by the City of Denver.

In this sense, CONSUL is an online software platform that offers various spaces for making proposals, debating, voting and even enables collaborative legislation among participants. In addition, it provides on-going support to face any technical issue that may arise. Consider.it is another interesting instrument that allow users to create a free forum to develop civil, organized and focused online dialogue through its capacity to moderate discussions, to generate dynamic pros and cons lists and surveys, export data, and run opinion analytics.

Deliberative online forums can be an excellent way to conduct large-scale discussions, participants can engage in the online debates and performance their daily activities simultaneously and it can create a dialogue/engagement with participants over a long period of

time. These features fit adequately with the project and its scope. For instance, this method could be implemented as a side activity for the Think Tank leaders to start the conversating regarding the future research lines. It could also be executed during a conference since it allows the participation of a huge audience.

5.2.2 Scenario workshop

This participatory planning instruments pretends to stimulate the dialogue, facilitate the exchanging experience and knowledge regarding a specific issue and all its dimensions, enhance the comprehension on the main problem/topic and create consensus solutions involving all the groups.

The purpose of this practice is to analyze a solution to manage a certain problem. It usually involves a two-day reunion gathering of around 25 – 30 representatives such as stakeholders, technology experts and private sector actors. The execution of this instrument is the following: a set of scenarios is suggested and used as visions or inspiration at the scenario workshop. Then, the participants in groups discuss these visions in order to create plans of action to address the problem.

This instrument involves three stages, but preparation needs to be done before executing it, i.e., an external planning group combined by specialist knowledge on the workshop topic write a set of scenarios and describe alternative pathways of development, which represent technical and organizational solutions considering social and political values. Lastly, it also requires a facilitator to dynamize the activity.

More specifically, in this case, the specialist knowledge group could be integrated by the Think Tanks leaders. Therefore, they can establish the set of scenarios, meaning, the possible future research lines. Moreover, during the execution of the workshop the stakeholders will be divided into groups based on roles or themes, according to their experiences and interests. The dynamic will combine group work, brainstorming, debate, voting, presentation, and plenary sessions. In the case of SOLO these theme or role-based groups could be integrated by the nine Think Tanks, that represent the eight goals of the Soil Mission in Europe, plus an extra one (biodiversity and conservation of nature).

The first stage focuses on critical analysis and participants comment on the scenarios based on their knowledge and experience delivering positive and negative feedback and emphasizing barriers. It is essential to make clear that the scenarios are not predictions, and the main objective is to use specific ones to assist stakeholders to create their own visions. The following step is related to the vision making process. In this sense, the actors use the knowledge gained from the first stage to develop their own personal visions, to later discuss within the group based on their theme to create different visions.

Lastly, the final phase is the implementation, in which actors present their ideas in plenum to discuss them. In this regard, the visions turn into action proposals and consequently, into a final action plan that contains the visions of all the groups with a focus on the solutions regarding implementation.

This method facilitates the involvement of affected parties in solving a local problem, stimulates in-depth discussion, invigorates the exchange of ideas, views, and knowledge among the diverse stakeholders, and promotes the creation of new ideas and recommendations for future actions. These strengths fit perfectly with the SOLO’s purposes.

5.2.3 Consensus conference

In this practice, a group of citizens (or other groups within the selected stakeholders) set the agenda and the basis for assessment within a problem area. The main goal is to enrich and create a debate on social matters.

10 to 30 citizens expose their views regarding a specific technological issue or area. Then, debate, consult experts and formulate recommendations during a 3 – 4-day long conference. This group meet two weeks prior to the conference to exchange and expand their knowledge from experts and documentation on the matter. The panel formulates key questions that later are presented to the expert panel and citizens at the conference. Within the first two days the experts present different views and citizens cross-examination of the said questions. The next step focuses on the report by the citizen panel integrating lessons learnt. And finally, on the last day recommendations are presented to the experts, policy makers, stakeholders, and the public in general in order to create an open and extensive debate.

To carry out this methodology is imperative to take into account the participation of a) project managers (director, assistant, among others), b) advisory/steering committee (5-6 persons), c) citizen panel (10-30 participants), d) expert panel (around 20 actors), e) facilitator.

Also, it is important to mention that every agent involved plays a particular role within this instrument. For instance: a) the project manager is in charge of recruit the different stakeholders, manage communication and oversees the budget, b) advisory/steering committee is integrated by regulators, policy makers, scientist, industry and non-governmental organizations selected by their knowledge, expertise and different point of views. Also, it is their responsibility to secure a democratic, transparent, and fair approach, c) the citizen panel while it's not composed by experts on the subject, play the main role since they are expected to ask critical questions regarding the data presented to them, d) the expert panel is responsible for ensuring heterogeneous points of view within the conference discussion, and e) the facilitator requires to have experience leading participatory and consensus-bases procedures since oversees the dialogue and the processes.

On the other hand, the activities at the conferences are executed as follows: on the first day, the experts expose their answers to the questions collected from the citizen panel. Then, the following day is focused on question clarification and discussion with the expert panel, the citizens, and the audience. On the third day, the citizen panel produces the final document, and finally, on the last day, the citizens present their conclusions and recommendations to the rest of the stakeholders. In this final step, the experts correct misunderstandings, but are not allowed to influence the views of the citizens panel. Therefore, the final document presents the consensus achieved by the citizen panel.

One of the greatest potentials this mechanism carries out is the opportunity to influence policy decisions and assess relevant issues. Also, it has been implemented for social experiments, research projects and avenues to promote social awareness and enhance public debate.

Furthermore, the promoters of this method suggest the following timeframe in order to ensure its proper application. Some experiences have been implemented within seven months, but twelve months is recommended.

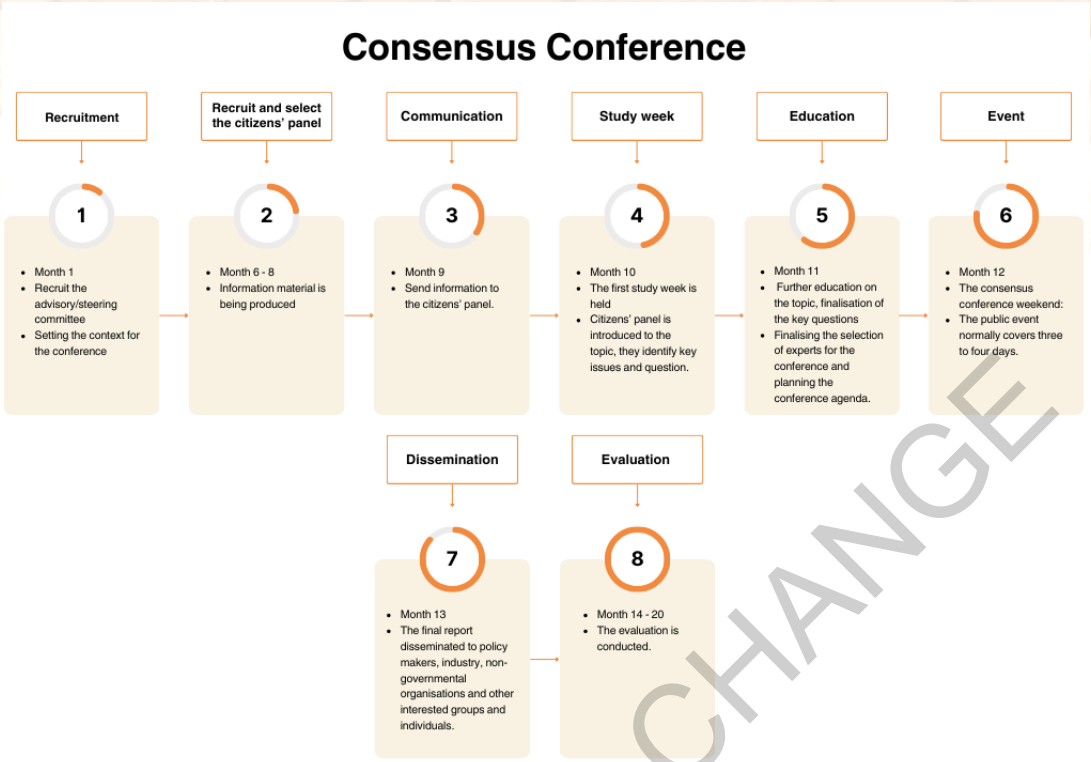

Figure 20: Consensus conference steps definition

Compilation based on information supplied by the Engage 2020 Action Catalogue

This practice is frequently used to address issues such as: health, demographic change and well-being, food security, sustainable agriculture, marine and maritime research, and bioeconomy. Also, in climate action, resource efficiency and raw materials.

Within the SOLO project the group of citizens that set the agenda could be integrated by the civil society organizations and citizens, environmental organizations, relevant practitioners, private sector and industry, and the public sector agents. And therefore, will debate and consult the experts, which in this case will be composed of researchers from both natural and social sciences and the Think Tank leaders. This first group will formulate key questions that will be presented to the expert panel in the conference that will take place in December in Barcelona. As mentioned above, in the next stage the citizens group creates a report integrating what they have learned. These are the steps we have considered that will take place in this first event. However, we have decided to implement the last phase of this method regarding the presentation of the recommendations and the debate during the Madrid convention. Hence, we will be able to conduct a broader and deeper discussion since we will be able to include other important stakeholders that will be attending this upcoming and significant event.

To illustrate it in a more detailed manner, we suggest the following work schedule for this participatory method focusing on the activities that will take place at the events.

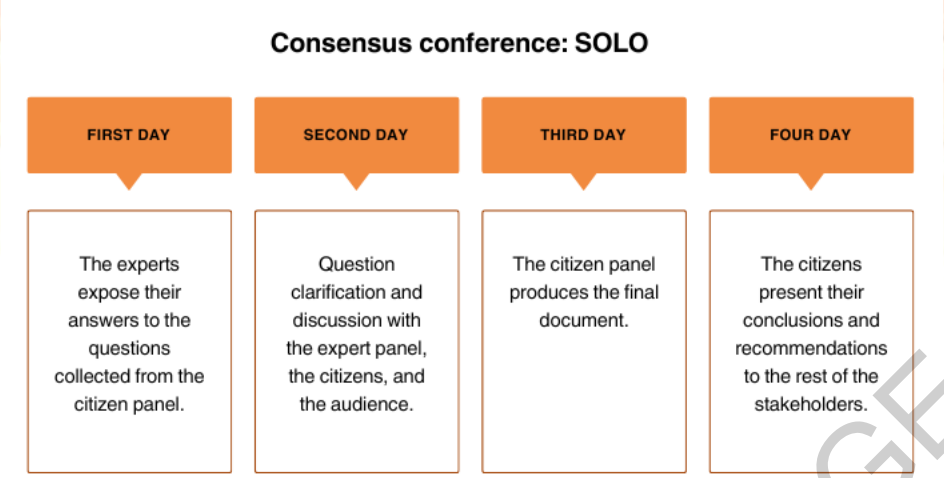

Figure 21: Consensus Conference example for SOLO

Compilation based on information supplied by the Engage 2020 Action Catalogue

5.2.4 World Café

The purpose of this method is to engage groups and is based on seven principles that support their design. Also, it offers a solution for today's fast-paced movement. It is based on the idea that people from different backgrounds are able to work together, no matter who they are.

World Cafés are conducted in a workshop format, and it encourages people to discuss things that matter to them. Also, the instrument is quite flexible so it can meet a wide range of needs or requirements. For instance, it could adapt to any location, circumstances, purposes, themes, etcetera.

Regardless of its methodological flexibility to address various issues. The promoters of this participatory practice have distinguished a series of elements and steps in order to ensure its proper application. For example, they have mentioned that setting up a relaxing environment, such as a café, is a must. Moreover, they have established eight steps in the development of a world café.

Once the right environment has been set and around four to five chairs are placed per table, it is time to start the first round of conversations that could last around 20 minutes. After the first round is finished, each member moves to another table, except for one person that stays put and plays the role of host for the next round. Then, this host fills the other members in on what was discussed on the previous round. It is important to emphasize that each round starts with a question designed for the purpose of the session. On the following step, the participants are invited to share the inputs from their conversations with the rest. The results are usually reflected in a visual manner.

To clarify this process, let's picture this: "Imagine a World Café with 200 participants at 50 tables. There are four participants at each table. During the first round of conversation, 4 opinions are represented at the table. When the participants change their tables for the first time, four new people sit together. Each of these participants brings 4 opinions to the next discussion. As a result,16 opinions are 'represented' at the table. This process continues in the subsequent rounds of conversations. During the third discussion round, 64 opinions are represented and during the

fourth round 256 opinions are represented. Theoretically, by only changing the tables three times, the opinion of every participant on the given topic is represented!" (World Café, 2022).

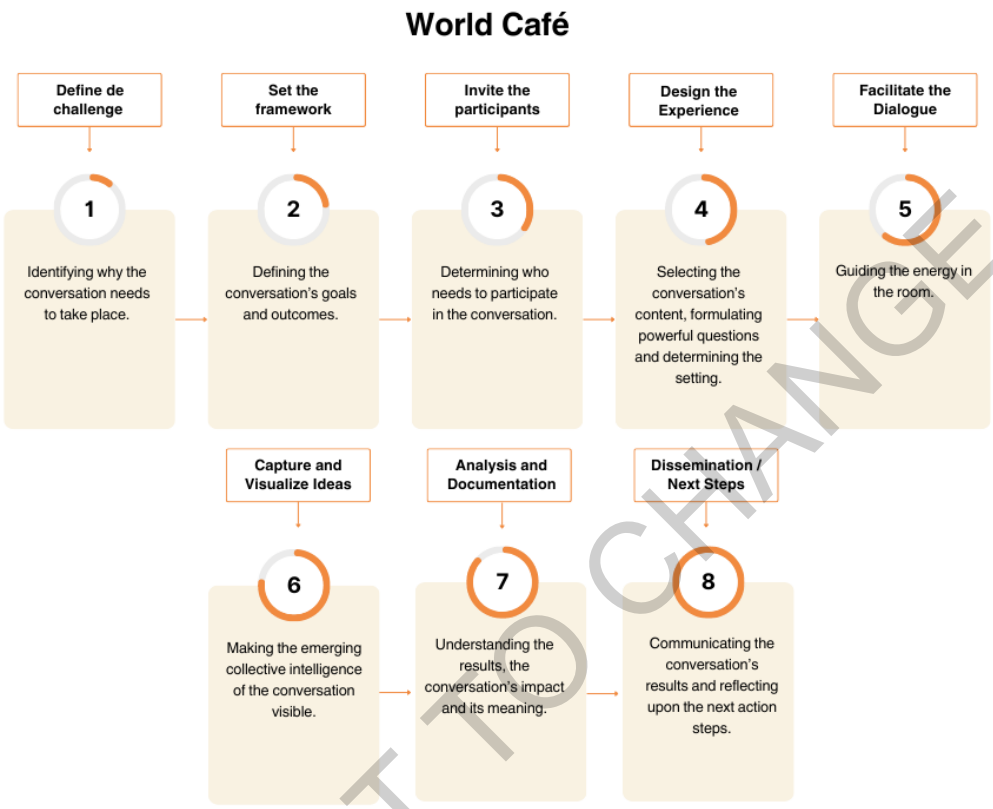

Figure 22: Example of word Café steps

Compilation based on information supplied by the World Café Europe

As mentioned above, the results are usually represented in a graphic recording. Hence, the main idea behind this is to collect people's ideas, visions and expressions through sketches, mind-maps, diagrams, word clouds, drawings, or any other visual representation of their inputs.

This method has been implemented in several contexts and with the purpose of facing matters such as: community building, decision-making, and identifying action steps. For instance, in Germany it was developed by the Munich City Council to address the integration of refugees into Munich's social sphere through a large-scale dialogue involving participants from diverse institutions, civil society and citizens who provide support to and cooperate with Munich's refugees. Also, more than 50 refugees from the Near East, Southern Asia and Africa joined in the conversation. Another example (concerning a different area and purpose) was the World Café carried out by EITB - Basque radio and television, which main objective was to launch a CSR (Corporate Social Responsibility) program incorporating Basque society's ideas to define it instead of conceiving it internally. 55 Basque citizens, 30 employees of EITB and 20 citizens who were interested in the topic participated.

To illustrate better the intention of graphic recordings, here are the examples that emerged from the EITB and the Munich's City Council experiences.

Figure 23: EITB's World Café graphic recording

***Source:** Social Responsibility (worldcafe.eu)*

Figure 24: Munich's City Council World Café graphic recording.

***Source:** Integration of Refugees (worldcafe.eu)*

Now, the question arises: how will we carry out this method within the SOLO? We believe this participatory practice adapts adequately with the characteristics of the project. For example, World Cafés contemplate the involvement of numerous individuals. In this sense, we are planning our upcoming event in which around 100 stakeholders or even more are expected to participate. In addition, it is a great tool to create a large-scale dialogue among actors, which is what we aim for. And, lastly, it enhances intensive collaboration and encourages the inclusion of different agents' perspectives regarding a certain topic or issue. The latter is one of the main approaches promoted by this project.

5.3 Prioritization methodologies in SOLO

The Analytic Hierarchy Process (AHP) is a basic decision-making approach employed with both the rational and the intuitive to choose from a diverse range of alternatives evaluated according to several criteria. Within this procedure, simple pairwise comparison judgements are conducted to create overall priorities to rank the said alternatives.

The structure of a decision problem is based on a hierarchy of three levels:

1) The first concerns the goal of the decision.
2) The following refers to the criteria.
3) The last level is where the alternatives will be evaluated.

In this regard, factors are organized from a general to a particular perspective, meaning that the first ones will be located at the upper level of the hierarchy, while the latter is at the lower level. The main idea behind this logic is to facilitate the assessment of the relevance of the elements in a certain level with respect to some of all the factors in the adjacent level above. As soon as this is completed, the AHP is quite simple to implement.

5.3.1 Philosophy, Procedure and Practice of the AHP

The Analytic Hierarchy Process is employed to acquire ratio scales from paired comparisons in multilevel hierarchies. It is a nonlinear framework designed to address deductive and inductive thinking.

This is made possible by taking several factors into consideration simultaneously, allowing for dependence and for feedback, and making numerical tradeoffs to arrive at a synthesis or conclusion. *"This is made possible by taking several factors into consideration simultaneously, allowing for dependence and for feedback, and making numerical tradeoffs to arrive at a synthesis or conclusion."* (Saaty & Vargas, 2012, p.3). Also, this methodology is used to conduct measurements in the physical and social spheres.

In this sense, cognitive psychologists have identified that humans make two types of comparisons. In the absolute, alternatives are compared with a reference that already exists in one person's memory and it is based on experience. On the other hand, in relative ones, alternatives are compared considering a common attribute.

Undoubtedly one of the most important parts of the process is structuring the decision as a hierarchy. To do so, it is essential to verify if the following question can be answered: *"Can I compare the elements on a lower level in terms of some or all of the elements on the next higher level"?* In this sense, Saaty & Vargas (2012) indicate a helpful manner to address this, which consist in *"work down from the goal as far as one can and then work up from the alternatives until the levels of the two processes are linked in such a way as to make comparison possible" (p.9).* Thus, below there are some suggestions recommended by Saaty, T.L. and Vargas, L.G. (2012).:

1. Identify overall goal. What are you trying to accomplish? What is the main question?
2. Identify subgoals of overall goal. If relevant, identify time horizons that affect the decision.
3. Identify criteria that must be satisfied to fulfill the subgoals of the overall goal.
4. Identify sub-criteria under each criterion. Note that criteria or sub-criteria may be specified in terms of ranges of values of parameters or in terms of verbal intensities such as high, medium, low.
5. Identify actors involved.
6. Identify actor goals.
7. Identify actor policies.
8. Identify options or outcomes.
9. Take the most preferred outcome and compare the ratio of the benefits to cost of making the decision with those of not making it. Do the same when there are several alternatives from which to choose.

10. Do benefit/cost analysis, using marginal values. Because we are dealing with dominance hierarchies, ask which alternative yields the greatest benefit; for costs, which alternative costs the most.

The Fundamental Scale:

The fundamental scale of values is essentially employed to represent intensities of judgements (see Table 3). However, there are moments in which elements are equal or basically almost equal in measurement. And, when its situations are presented, it is necessary to compare them to determine how many times one fraction is larger than the other. In a more illustrative manner, sometimes the comparisons are presented between 1 and 2, and what is required is to estimate verbally the values such as 1.1, 1.2, 1.3… 1.9, and so on. The point to be made is to continue the verbal scale to demonstrate that *"1.1 is a "tad", 1.3. indicates moderately more, 1.5 strongly more, 1.7 very strongly more and 1.9 extremely more."* (Saaty, T.L., and Vargas, L.G. 2012).

Table 4: Fundamental Scale: intensity, definition, and explanation.

Intensity of Importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective.
2 **3**	Weak Moderate importance	Experience and judgement slightly favor one activity over another
4 **5**	Moderate plus Strong importance	Experience and judgement strongly one activity over another
6 **7**	Strong plus Very strong or demonstrated importance	An activity is favored very strongly over another; its dominance demonstrated in practice.
8 **9**	Very, very strong Extreme importance	The evidence favoring one activity over another is of the highest possible order affirmation
Reciprocals of above	If activity *i* has one of the above nonzero numbers assigned to it when compared with activity *j*, then j has the reciprocal value when compared with *i*	A reasonable assumption
Rationales	Rations arising from the scale	If consistency were to be forced by obtaining *n* numerical values to span the matrix.

Source: Elaborated by the authors based on Saaty, T.L., Vargas, L.G. (2012).

How to structure a decision problem?

Deciding the factors that will be included in the structure is probably the most creative part of the decision-making process. It is important to emphasize that when structuring hierarchies, it should be included detailed information to represent the problem as meticulously possible, but not so extensively as to *"lose sensitivity to change in the elements."* (Saaty & Vargas, 2012, p.2). Different aspects regarding i) the problem, (such as, issues or attributes) and ii) the participants are essential when developing a hierarchy. Therefore, organizing these aspects in hierarchy serve two purposes:

1) Allows an overall perspective of the relationships involved in the given situation.
2) Identify if the issues of the same order or magnitude are being compared.

It is also relevant to highlight that the nature of the elements should be homogeneous to be compared. Furthermore *"the hierarchy does not need to be complete; that is, an element in a given level does not have to function as a criterion for all the elements in the level below."* (Saaty & Vargas, 2012, p.2). Hence, subhierarchies can be created within a hierarchy, sharing a common element at the topmost.

In addition, it is possible to insert or eliminate levels and elements to clarify the priorities or to focus exclusively on one or more sections of the system. Also, aspects of great importance can be explained in deeper detail. On the other hand, elements that are less relevant can be described in a general manner and placed at the top of the hierarchy.

"Setting priorities requires that the criteria, the sub-criteria, the properties or features of the alternatives be compared among themselves in relation to the elements of the next higher level." (Saaty & Vargas, 2012, p.2).

And lastly, it is possible to exclude less important elements for further consideration after the process of judgement regarding the impact of the elements, and the priorities have been processed for the hierarchy as a unity.

Below a Figure (25) that illustrates an example of a three-level hierarchy.

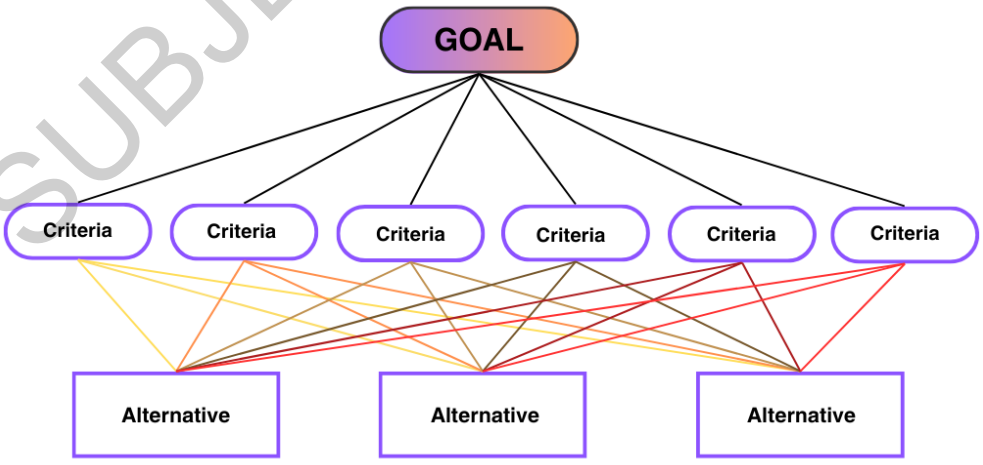

Figure 25: Example of a three-level hierarchy

Source: Elaborated by the authors based on Saaty, T.L., Vargas, L.G. (2012). How to Make a Decision. In: Models, Methods, Concepts & Applications of the Analytic Hierarchy Process. International Series in Operations Research & Management Science.

Example I:

Saaty, T.L. and Vargas, L.G. (2012) set the following example: a family of average income wants to buy a house and need to choose from three different options. First, the **goals, factors and options need to be identified and organized**.

Therefore, the family has identified eight factors that the house needs to have. These factors are organized in three categories: economic, geographic and physical. In this sense, when applying the AHP, **it is necessary to structure the problem into a hierarchy** (Fig 25). As mentioned before, on the top needs to be located the overall goal, meaning, the goal of *"Satisfaction with house"*, on the following level is the criteria that contribute to achievement of the goal, in this case, the eight factors. And, finally on the third level are located the options (e.g., the three candidate houses) that are being evaluated considering the criteria (second level). The eight factors are the following:

Size of House: Storage space; size of rooms; number of rooms; total area of house.
Transportation: Convenience and proximity of bus service.
Neighborhood: Degree of traffic, security, taxes, physical condition of surrounding buildings.
Age of House: Self-explanatory
Yard Space: Includes front, back, and side space, and space shared with neighbors.
Modern Facilities: Dishwasher, garbage disposal, air conditioning, alarm system, and other such items.
General condition: Extent to which repairs are needed; condition of walls, carpet, drapes, wiring; cleanliness.
Financing: Availability of assumable mortgage, seller financing, or bank financing.

Lastly, here is an example of the representation of the previous situation.

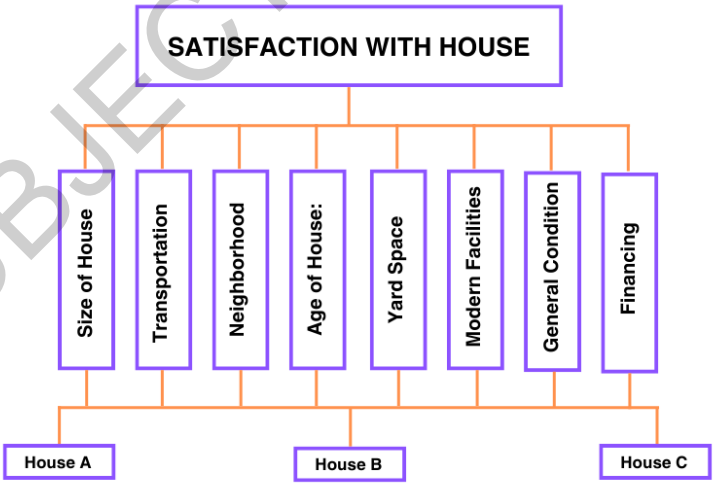

Figure 26: Example of three-steps hierarchy

Source: Elaborated by the authors based on Saaty, T.L., Vargas, L.G. (2012). How to Make a Decision. In: Models, Methods, Concepts & Applications of the Analytic Hierarchy Process. International Series in Operations Research & Management Science.

Comparative judgment is the next step in this process. Hence, it's time for the family to decide which elements are more important with respect to the overall goal. In this sense, the questions that need to be asked in this step is and comparing two criteria is: *"of the two alternatives being compared, which is considered more important by the family and how much more important is it with respect to family satisfaction with the house, which is the overall goal"?* (Saaty & Vargas, 2012, p.13).

In the Table 5 are listed the eight factors previously mentioned, along with the resulting vector of priorities. The **Fundamental Scale** is employed to submit the judgements, *"first verbally as indicated in the scale and then associating the corresponding number. The vector of priorities is the principal eigenvector of the matrix. This vector gives the relative priority of the factors measured on a ratio scale. That is, these priorities are unique to within multiplication by a positive constant. However, if one ensures that they sum to one they are always unique. In this case financing has the highest priority, with 33% of the influence."* (Saaty & Vargas, 2012, p.13).

Also, in this table (5) the criteria are represented by the number previously assigned to each of them. In this regard, for instance, when comparing *"Size of House"* (on the left) with *"Size of House"* on top, an equal value is assigned. Nevertheless, when considering a different factor such as *"Transportation",* which is a factor with higher importance for the family a 5 is added to the 1-2 intersection, or in other words, to the first row, second column position (as highlighted in red). Therefore, the same value goes for the 2-1 position.

We keep moving forward with the comparison and when taking *"Size of House*" located in the first row and compare it with *"General Condition"* in the seventh column, which is not preferred but slightly dominated by *"General Condition"*, a 1/3 is added in the 1-7 intersection. Thus, in the same way a 3 is automatically inserted in the 7-1 position. *"The consistency ration C.R. is equal to 0.169 and one needs to explore the inconsistencies in the matrix with the help of Expert Choice to locate the most inconsistent one and attempt to improve it if there is flexibility in the judgment. Otherwise, one looks at the second most inconsistent one and attempt to improve it if there is flexibility in the judgment. Otherwise, one looks at the second most inconsistent judgment and attempts to improve it and so on"*. (Saaty & Vargas, 2012, p.14).

Table 5: Pairwise comparison matrix for level I

	1	2	3	4	5	6	7	8	Priority Vector
1	**1**	**5**	3	7	6	6	1/3	1/4	0.173
2	1/5	1	1/3	5	3	3	1/5	1/7	0.054
3	1/3	3	1	6	3	4	6	1/5	0.188
4	1/7	1/5	1/6	1	1/3	1/4	1/7	1/8	0.018
5	1/6	1/3	1/3	3	1	1/2	1/5	1/6	0.031
6	1/6	1/3	1/4	4	2	1	1/5	1/6	0.036
7	3	5	1/6	7	5	5	1	1/2	0.167
8	4	7	5	8	6	6	2	1	0.333

λmax = 9.669 C.R. = 0.169

Source: Elaborated by the authors based on Saaty, T.L., Vargas, L.G. (2012). How to Make a Decision. In: Models, Methods, Concepts & Applications of the Analytic Hierarchy Process. International Series in Operations Research & Management Science.

Regarding the pairwise comparisons in bottom level, in other words, the three houses' options. In this sense, they are compared to one another considering how much better is one than the other in satisfying each criterion (located in the second level). Hence, the three houses are being

pairwise compared with these eight factors (size of house, transportation, neighborhood, age of house, yard space, modern facilities, general condition, financing).

To better understand the process of the judgements, a brief description of the houses is presented. This table (6) gives the matrices of the houses and their local priorities with respect to the elements on level two.

Table 6: Pairwise comparison matrices for level 2

	A	B	C	DISTRIBUTIVE MODEL	IDEAL MODEL
SIZE OF HOUSE (A)					
A	1	6	8	0.754	1.000
B	1/6	1	4	0.181	0.240
C	1/8	1/4	1	0.065	0.086
TRANSPORTATION (B)					
A	1	7	1/5	0.233	0.327
B	1/7	1	1/8	0.005	0.007
C	5	8	1	0.713	1.000
NEIGHBORHOOD (C)					
A	1	8	6	0.745	1.000
B	1/8	1	1/4	0.065	0.086
C	1/6	4	1	0.181	0.240
AGE OF HOUSE (D)					
A	1	1	1	0.333	1.000
B	1	1	1	0.333	1.000
C	1	1	1	0.333	1.000
YARD SPACE (E)					
A	1	5	4	0.674	1.0001/6
B	1/5	1	1/3	0.101	0.150
C	1/4	3	1	0.226	0.335
MODERN FACILITIES (F)					
A	1	6	6	0.747	1.000
B	1/8	1	1/5	0.060	0.080
C	1/6	5	1	0.193	0.258
GENERAL CONDITION (G)					
A	1	1/2	1/2	0.200	0.500
B	2	1	1	0.400	1.000
C	2	1	1	0.400	1.000
FINANCING (H)					
A	1	1/7	1/5	0.072	0.111
B	7	1	3	0.650	1.000
C	5	1/3	1	0.278	0.428

a) λmax = 3.136 C.I. = 0.068 C.R. = 0.117

b) λmax = 3.247 C.I. = 0.0124 C.R. = 0.213

c) λmax = 3.130 C.I. = 0.068 C.R. = 0.117

d) λmax = 3.000 C.I. = 0.000 C.R. = 0.000

e) λmax = 3.086 C.I. = 0.043 C.R. = 0.074

f) λmax = 3.197 C.I. = 0.099 C.R. = 0.170

g) λmax = 3.000 C.I. = 0.000 C.R. = 0.000

h) λmax = 3.065 C.I. = 0.032 C.R. = 0.056

Source: Elaborated by the authors based on Saaty, T.L., Vargas, L.G. (2012). How to Make a Decision. In: Models, Methods, Concepts & Applications of the Analytic Hierarchy Process. International Series in Operations Research & Management Science.

House A: This house is the largest of them all. It is located in a good neighborhood with little traffic and low taxes. Its yard space is comparably larger than that of houses B and C. However, its general condition is not very good, and it needs cleaning and painting. Also, the financing is unsatisfactory because it would have to be financed through a bank at a high interest.

House B: This house is a little smaller than House A and is not close to a bus route. The neighborhood gives one the feeling of insecurity because of traffic conditions. The yard space is fairly small, and the house lacks the basic modern facilities. On the other hand, its general condition is very good. Also, an assumable mortgage is obtainable, which means the financing is good with a rather low interest rate. There are several copies of B in the neighborhood.

House C: House C is very small and has few modern facilities. The neighborhood has high taxes but is in good condition and seems secure. The yard space is bigger than that of House B but is not comparable to House A's spacious surroundings. The general condition of the house is good, and it has a pretty carpet and drapes. The financing is better than for A but not better than for B.

The next step within the AHP process consists of **synthesizes the priorities.** And there are two paths to follow. The distributive model is the first one. *"In order to establish the composite or global priorities of the houses we lay out in a matrix the local priorities of the houses with respect to each criterion and multiply each column of vectors by the priority of the corresponding criterion and add across each row, which results in the composite or global priority vector of the houses*. The other alternative is the ideal mode. *"Here the priorities of the houses for each criterion are first divided by the largest value among them. That alternative becomes the ideal and receives a value of 1. One then multiplies by the priority of the corresponding criterion and adds as before.*

House A is preferred if for example copies of B matter and hence the distributed mode is used. In a large number of situations with 10 criteria and 3 alternatives, the two modes gave the same best choice 92% of the time. House B is the preferred house if the family wanted the best house regardless of other houses and how many copies of it there are in the neighborhood and hence the ideal mode is used." (Saaty & Vargas, 2012, p.16)

Example II

Another example is when Finland's parliament was deciding what type of power plant to build. They were concerned that the decision would affect the nation's economy, health, safety, and environment. In this sense, the primary goal of was to select the power plant that would serve the overall welfare of the nation. And, therefore, each of main criteria was arranged into sub-criteria, followed by the alternatives, meaning the different power plant options. The hierarchy was structured in this way:

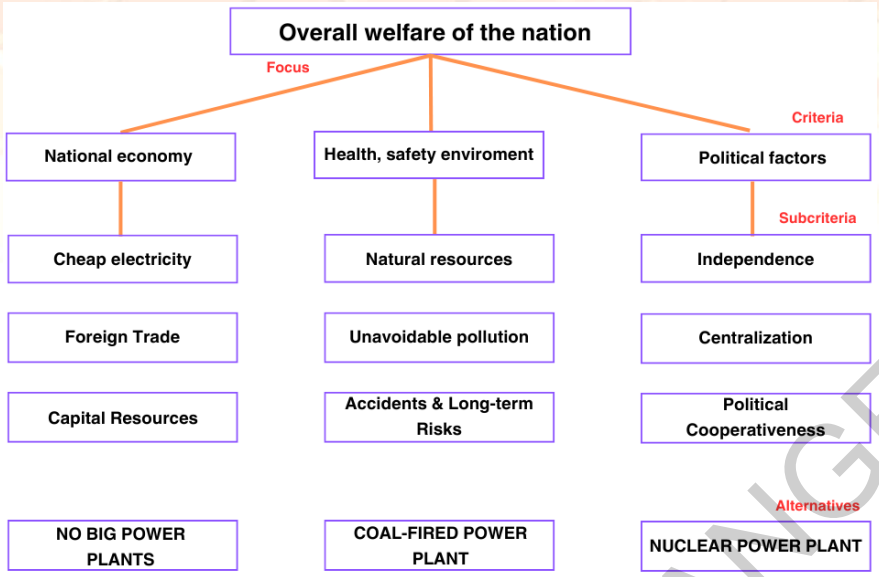

Figure 27: Example II of the AHP

Source: Elaborated by the authors based on Saaty, T.L., Vargas, L.G. (2012). How to Make a Decision. In: Models, Methods, Concepts & Applications of the Analytic Hierarchy Process. International Series in Operations Research & Management Science.

It is important to emphasize that the hierarchy structure should encompass the complexity of the issue, but also, simple enough to accept any required modifications. In this sense, for the Finnish parliament the previous model represents the difficulty of the situation and that could be approached as a political unit.

The Parliament *"have to establish priorities for the main criteria by judging them in pairs for their relative importance, thus generating a pairwise comparison matrix" Judgements which are represented by numbers from the fundamental scale below are used to make comparisons. The number of judgements needed for a particular matrix of order n, the number of elements being compared, is n(n – 1)/2 because it is reciprocal and the diagonal elements are equal to unity."* (Saaty, 1987, p. 163).

The following step is *"to compare the subcriteria that belong to each of the main criteria, thus constructing three more pairwise comparison matrices for level 3. Then, the three alternatives are compared with respect to each of the subcriteria, leading to nine pairwise comparison matrices for level 4. The final step is to weight or synthesize the results to obtain the final priorities of the three power plants."* (Saaty, 1987, p. 163).

5.3.2 Soils for Europe and Analytic Hierarchy Process (AHP)

Within SOLO project, the Analytic Hierarchy Process is suggested to prioritize the decisions regarding the future research lines for soils. During the roadmapping process, several GAPs are going to be identified but, which ones are prioritized by the EU? Instead of giving them as equal, we take the challenge to prioritize them within the TTs and after a debate, the ultimate goal is to give a list of the R&I GAPs with a prioritization to the EC.

In this sense, the stakeholders from each TT would select the criteria, and the alternatives to build the hierarchy structure that better suit the project's objective (such as the ones presented in the examples above).

Stakeholders would debate and finally determine the criteria and its prioritization, as well as the alternatives to incorporate in the hierarchy. To ensure an inclusive decision-making process every actor must participate. In other words, civil society, NGOs, farmers, policymakers, scientists (from natural and social sciences), advisors, fertilizer companies, and so on, will be actively involved in this task. It is needed to be conscient that, as highlighted before, the presence of the stakeholders involved in the project will highly determine the results of the process.

It is key to emphasize that the outcomes of the analytic hierarchy process will be mandatory review within the Think Tank, and therefore, it will be decided whether this result is adopted or not.

The ultimate objective of this method within the SOLO project is to prioritize the future research lines and visions in a more quantifiable manner to avoid any possible bias. If prioritization dissensus arises, the roots of it will be presented and analysed in the overall scoping document. And an indicative of consensus based on the 2/3 of the population participating in the debate will be accepted.

A rather rustic example might look as follows:

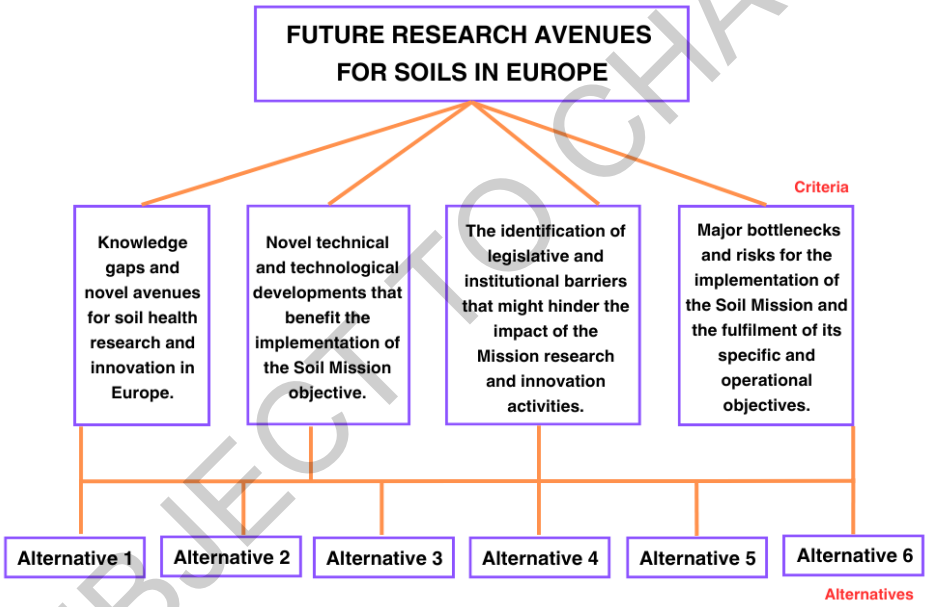

Figure 28: Hierarchy structure for SOLO TTs proposal

Source: Elaborated by the authors

It is important to highlight that the previous example is an initial draft of how the AHP could adapt to the concept of the SOLO project. In the case of applying the AHP process, stakeholders will be free to design the model that best suits them. Moreover, we'll provide a list of options that could be implemented within this project to achieve the established goals. However, the final decision falls in the hands of the Think Tanks.

Once the results arise, they will be validated by the TT itself and open the discussion to other TTs as well.

6 Monitoring and evaluating the engagement.

Evaluating the effectiveness of the engagement through the process is essential to determine whether it has been successful. This assessment could provide information regarding the value of research outcomes, and, for example, to illustrate to stakeholders how their participation has been used. To start the evaluation process, it is eminent to define the indicators that will guide the assessment beforehand with the stakeholders.

There are two major types of evaluation. The first one is denominated *"Summative evaluation",* which is commonly applied for accountability, audit purposes or to demonstrate stakeholders how their inputs to the engagement process have been adopted. Hence, data gathering is required to exhibit that specific goals have been achieved. Nevertheless, this sort of data can be quite limited to understanding the nature of engagement since it focuses on the outcomes, instead of the process itself. The *"Formative evaluation"* might facilitate research and stakeholders to learn from the engagement procedure, to do better in the future. It also might be participatory, integrating more qualitative methods, like interviews, focus group and observation to explain how the engagement was.

In this sense, these two could be applied to evaluate the success of the engagement (have the aim and objectives of the engagement process been met?), the process of engagement (were the methods selected appropriate?), the impact of procedure (have there been any unexpected outcomes?) and, last but not least, the fulfillment of the aims of the stakeholders.

Another significant matter regarding the evaluation procedure is when to carry it out. In this regard, it should be considered in the early stages of the engagement process, through to undertaking the engagement and considering the results.

In the BiodivERsA stakeholder engagement handbook, there is available a table that can be used as a resource for the evaluating process.

Table 7: Template for an evaluation process

	WHAT DO YOU WANT TO KNOW?	WHAT EVALUATION METHODS WILL BE USED?	HOW WILL THE EVALUATION BE CONDUCTED?
PLANNING PROCESS			
ENGAGEMENT			
BENEFITS /OUTCOMES			

Source: Generated by the authors, based on The BiodivERsA Stakeholder Engagement Handbook by Durham E., Baker H., Smith M., Moore E. & Morgan V. (2014).

The evaluation process focuses on three stages. These are:

1) From the outset: It is highly important to consider the evaluation at the very beginning of the process, therefore, you can ensure that it is based on the aims and desired outcomes of the research project.

2) Through the process – on – going evaluation: Engagement activities should be monitored and reviewed during the implementation of the process to guarantee the engagement goes accordingly to the purpose. Also, to make the proper adjustments when necessary.

3) Final evaluation: Besides measuring if the engagement has fulfilled its aims and objectives, it should also consider whether the process was adequate and fit for purpose. Moreover, it is essential that stakeholders can identify if their inputs have been employed within the engagement process. In this sense, it is necessary to maintain proper communication with the stakeholders.

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8 Appendix 1

Research & Innovation Gaps (15.05.2023)

Contribution from SOLO to the scoping document of the next round of funding

While we identify knowledge gaps to specific Soil Mission objectives, it is important to note that many of these can co-exist in one single call. Also, it is clear that many of these topics require a multidisciplinary consortium and approaches that allow maximising impact. Therefore, we also suggest that the calls promote the involvement of practitioners and researchers from multiple disciplines beyond soil science and soil ecology (e.g., law-making, psychology, political sciences, and chemistry, among others), as well as the pairing of experimental facilities (that can draw mechanistic and causal conclusions) and observational studies (e.g., like the ones implemented by EUSO in the framework of LUCAS).

Soil Mission objective-specific topics for the next call:

Reduce desertification and land degradation

- Identify the extent and intensity of land degradation across EU Member States, considering multiple sources of degradation (e.g., climate-driven, pollution and contamination, land change, overexploitation, etc.) and making use of the latest monitoring mechanisms (e.g., EUSO, Copernicus);
- Identify, test and standardise (when possible) best practices across land use types to prevent the effects of desertification and land degradation, and restore healthy soils.

Conserve soil organic carbon stocks

- Develop new knowledge on long-term trends in European agricultural soils, in particular on mechanistic understanding of the consequences of intensive use and land use change on soil functions and their impact on soil organic carbon stocks;
- Explore conceptual, legal, policy and practical ways of how can soil organic carbon stocks be assessed and quantified in an overall health concept that includes healthy plants (food and feed), clean water, healthy animals, and people, in particular in the context of "climate-smart" agriculture, horticulture, and forestry, and practices adaptation to new climatic extremes;
- Produce significant knowledge concerning safe and energy-efficient recycling of waste materials in soil, and its impact on soil organic carbon stocks and soil health, in particular, related to soil and ecosystem restoration approaches.

Stop soil sealing and increase re-use of urban soils

- Investigate what is the degree of soil sealing associated with different land take processes, how it is context driven (e.g., across Member States), and what social, economic, and cultural factors drive the decisions of landowners and land managers about soil sealing, including the potential effects on soil health and the implications of current soil literacy;

- Identify urban-specific monitoring methods and essential soil biodiversity variables that allow track not only soil sealing (e.g., in connection to work developed by Copernicus) but also the functional and ecological consequences of the process;
- Explore current governance, legal and policy instruments related to soil sealing, including property rights and how these influence decision-making process and the protection of soil resources across Member States.

Reduce soil pollution and enhance restoration

- Identify the distribution and pollutants composition of critically degraded soils across Europe, including the identification of potentially vulnerable soils;
- Assess soil properties and linkages with other polluting pathways and identify feasible approaches to large-scale soil pollution reduction and restoration;
- Explore new innovative compounds that can contribute to more sustainable farming by reducing their persistence in the environment and their contamination effects on multiple (not single organism) soil organisms and their trophic networks.

Prevent erosion

- Develop a Soil Erosion monitoring system at the farm scale, including a coordinated network of research institutions, practitioners, and farmers who monitor soil erosion at the farm scale to improve the understanding of both natural and anthropogenic soil erosion processes and their interactions;
- Develop research to scale up soil erosion processes and estimate rates in space and time, including exploring the effects of multiple land use and climatic scenarios.

Improve soil structure to enhance soil biodiversity

- Investigate the importance of the diversity of soil viruses, bacteria, and other soil organisms in relation to land management in the stabilization of the soil structure and vice versa (e.g., including research on the spatial positive and negative impacts of bioturbation, and a proper representation of soil aggregates stability across European soils);
- Investigate the importance of soil structure and stable aggregates on the soil-plant interface, the consequences for plant production, and for soil multi-functionality.

Reduce the EU global footprint on soils

- Establishing a baseline for the EU global footprint on soils including the revision of the EU imports of food, feed, fibre, biomass, minerals and other lithological resources;
- Exploring a set of trajectories or vision-positive scenarios towards significant reductions of the EU footprint across sectors, including novel finance and economic mechanisms (including commercial policies that aim to reduce the EU footprint), the introduction of guidelines or requirements for better food production and more sustainable resource extraction;
- Exploring the social, economic and environmental implications of shifts of product sources to areas with less vulnerable soils, implementation of improved (more sustainable) production systems, but also soil restoration practices that undo past degradation.

Improve soil literacy in society

- Development and investigation of the consequences of new practical curricula that are adapted across educational levels and can improve the knowledge of citizens on soil health and its ecology, particularly in citizens' perception of soils, soil needs and social implications of healthy soils;
- Investigate the level of impact of current knowledge, soil protection strategies, and capacity-building programmes in the perception of citizens, practitioners, and policymakers of what constitutes a healthy soil and the main strategies to improve it;
- Investigate what are the current governmental structures across the Member States that support the improvement of soil literacy and identify best practices, improvements and novel approaches in the access to soil information and training for stakeholders, private sector engagement, and educational programs.

Nature conservation of soil biodiversity

- Identify nature conservation practices that enhance the quality of soil habitats, the protection of soil organisms and the multi-functionality of soils according with local environmental conditions;
- Investigate the effects of current different types of conservation areas on soil organisms and identify potential changes that are needed to improve nature conservation of soil and the restoration of soil habitats across European landscapes and land-use types;
- Explore future scenarios (including nature future scenarios) for multiple soil organisms and establish feasible conservation goals as well as identify vulnerable taxa of geographic areas that require special attention.

9 Appendix 2

Soils for Europe

XXX Think Tank

SCOPING DOCUMENT

Date, 2023

Author(s)

Author affiliations

Prepared under contract from the European Commission

Grant agreement No. 101091115
Horizon Europe Research and Innovation and other actions to support the implementation of a mission in the area of Soil health and Food

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Table of contents

Preface

Main text (Arial point 11; single line spacing; full justification; 1 line spacing between paragraphs; no other spacing before or after paragraphs)

Bullet lists:

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Table 8: Table caption (above table).

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Row label	1.0	1.0	1.0	1.0	1.0	1.0
Row label	1.0	1.0	1.0	1.0	1.0	1.0

Figure 29: Figure caption (below figure).

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Project Summary

Soils are under multiple pressures, including climate change, urbanization, pollution, overexploitation, and biodiversity loss. The specific objectives of the EU Mission 'A Soil Deal for Europe' address all these pressures, needing now: i) actionable research and innovation roadmaps for its concretization; and ii) an overarching transdisciplinary agenda to identify the thematic and regional trade-offs and synergies that allow the sustainable use, management, and protection of European soils. Defining such an agenda requires the direct involvement of a wide range of stakeholders, bringing together multiple perspectives and ecological, environmental, economic, and social contexts. To do that, at the core of SOLO will be the implementation of Think Tanks, one for each Soil Mission objective, with the aim of co-creating knowledge and identifying the knowledge gaps, drivers, bottlenecks, and novel approaches, as well as suggesting KPIs to monitor the progress of the Mission R&I related activities. Together with an open digital platform, the Think Tanks will function as an operational tool for implementing a participatory process that will last beyond SOLO's lifespan. SOLO will also address the potential differences in the regional implementation of the Soil Mission by testing its approach in four co-creation Regional Nodes, generating their own regional roadmaps that will be matched with the European ones. These explicit linkages between the co-creation mechanisms and the different project components aim to produce a shared understanding of needs and comprehensive identification of research and innovations priorities and other critical activities for the success of the Soil Mission.

Project background

The main goal of SOLO is to deliver actionable transdisciplinary roadmaps for future soil-related research activities in the EU, which contribute to achieving the objectives of the Soil Mission. This will be done by working on three axes: i) identification of the major knowledge gaps in research, driving forces and bottlenecks (10 Think Tanks); ii) assessment of synergies and trade-offs between the roadmaps of the Soil Mission Objectives and European regions (Regional Nodes), and iii) co-development of an Operational Framework and a set of indicators to monitor the Soil Mission progress.

Concisely, the Soil Mission Think Tanks aim to identify knowledge gaps and novel avenues for European soil research, innovation, and other actions in the context of the Soil Mission objectives. The Think Tanks goals as trigger and deployment of participative action research processes are:

- Co-develop the Mission Objective roadmaps,
- Facilitate knowledge exchange
- Establish a strong connection to current and future EU and international
- Soil Health projects.

List of abbreviations

EU	European Union
KPIs	Key Performance Indicators
RN	Regional Nodes
RRI	Responsible Research and Innovation
SMO	Soil Mission Objectives
SNK	Soil Network of Knowledge
SOLO	Soils 4 Europe Project
ToR	Terms of Reference
TT	Think Tanks

1 Introduction

Why do we still need research on this TT particular topic?

In what would this research focus on?

2 State-of-the-Art

The state of the art encompasses the entire body of knowledge and the highest degree that has been achieved to date on the subject.

Examples of what could be included in the State-of-the-Art section are:

- Knowledge about the research topic.
- Demonstrates the degree of relevance of the project.
- Different approaches.
- Wealth of material from past research.

3 Knowledge Gaps

Think Tanks will identify knowledge gaps and novel avenues for European soil research, innovation, and action in the context of the Soil Mission specific and operational objectives.

Examples of what could be included in the Knowledge Gaps section are:

- Overview on the topic
- Identify the knowledge gaps in the literature.
- Explain how you attempt to address in your project this lack of knowledge or understanding.

4 Engagement within the Think Tanks.

One of the primary benefits of stakeholder engagement is the creation of links between science and society, providing access to additional information or resources, and improving the relevance or utility of the research to users and beneficiaries. Concretely, through engagement, the project's result can be tailored to local contexts, increase the possibility that the outcomes are applied, and therefore, have a positive impact.
In this line, there are several interesting features that should be emphasized within this project. For instance, one of its key attributes is the tangible outcome with high impact level that would originate from it. In other words, stakeholders can consensually determine the future research lines for soils in Europe. We strongly believe that this will encourage and enhance the commitment of said stakeholders during the implementation of this project.

- Identify key stakeholders within the project.
- Explain the scope of the project.
- Explain the benefits of the research.
- Explain the strategies to enhance engagement within the TT.
- Explain strategies to strengthen engagement within the stakeholders (event in Barcelona).

5 Roadmap

Examples of what could be included in the Deliverables section are:

- What are the major outputs of the project, including quantities?
- What are measures of project success?
- What is promised to the “customer”?
- As appropriate, attach a software requirements specification document.

6 Prioritization

Explain how the process of prioritization will be conducted within the Think Tanks.

Examples of what could be included in the Prioritization:

- Explain the AHP.
- Examples of the AHP
- Explain the relationship between AHP methodology within the SOLO project.

7 Acknowledgements

8 References

10 Appendix 3

Extracted from Dicks LV, Haddaway N, Hernández‐Morcillo M, Mattsson B, Randall N, Failler P, Ferretti J, Livoreil B, Saarikoski H, Santamaria L, Rodela R, Velizarova E, and Wittmer H. (2018). Knowledge synthesis for environmental decisions: an evaluation of existing methods, and guidance for their selection, use and development – a report from the EKLIPSE project (p34-35)

Scoping review synthesis

Summary of the method

A structured, step-wise methodology, preferably following an a priori protocol to collate and describe existing research evidence (traditional academic and grey literature) in a broad topic area, following a systematic map methodology but with components of the process simplified or omitted to produce information in a short period of time. This is not the same as the scoping stage of a systematic review. The method has been called 'Quick Scoping Review' (Collins et al. 2015). The exact set of methods used, or the components of systematic map that are left out is flexible, and the method itself is not standardised internationally. A standardised version of Quick Scoping Review has been defined by the UK Government (Collins et al. 2014), and this is used for the time and costs estimates below. Reporting requirements in Collins et al. (2014) include: protocol of methods, fates of all articles screened at full text, transparent documenting of all methods used. For more general scoping review, there are no strict reporting requirements, as there are no internationally agreed method guidelines. Scoping reviews are not usually endorsed by a co-ordinating or certifying body. This leads to a wide range in method details, reporting and overall review quality.

Key references

Collins A et al (2014) The Production of Quick Scoping Reviews and Rapid Evidence Assessments: A How to Guide. Joint Water Evidence Group, UK.
Tricco AC et al (2016) A scoping review on the conduct and reporting of scoping reviews. BMC Medical Research Methodology 16, 15.
Examples of application The UK Department of Environment Food and Rural Affairs (Defra) has commissioned scoping reviews to inform policy on pesticide regulation (James et al. 2014) and to explore the scope for systematic review or summaries to inform policy on sustainable intensification of agriculture (part of this programme: www.siplatform.org.uk).
The report is available as: Knight et al (2018) Defra Sustainable Intensification Research Platform Project 1: Integrated Farm Management for Improved Economic, Environmental and Social Performance (LM0201) Available from: http://randd.defra.gov.uk/Document.aspx?Document=14132_SIP1_scoping_study_Final.pdf
James K, Randall N and Millington A (2014) The impact of Pesticides Used in Amenity on Controlled Waters in the UK. A Quick Scoping Review.

Strengths	Weaknesses
Follows methodological principles of systematic maps Often include searches for grey literature Potentially upgradable into a full systematic review/systematic map without complete repetition Suitable for broad topics	Not as reliable as a full systematic map Protocol typically not externally peer-reviewed Does not usually provide detailed analysis of the content/findings of evidence. Often just shows *what* evidence exists

Scoping review	
Cost[11]	Staff (1-6 months FTE), subscriptions (database access, article access), software (reference/specialist review management), travel and subsistence, expert (informatician, visualization/database specialist) Affected by: size of the evidence, existence of previous reviews, need for specialist expertise, complexity of the question, required level of rigour
Time required	1-6 months Affected by: quantity of literature, availability of staff, response time
Repeatability	Moderate
Transparency	High (if conducted well, i.e. endorsing organisations), protocol is important
Risk of bias	Medium (if conducted well). Should acknowledge risk of bias transparently in evidence base and review method
Scale (or level of detail)	Independent of scale (any)
Capacity for participation	Potential consultation throughout
Data demand	High
Types of knowledge	Scientific/technical, explicit
Types of output	Written report plus other communication materials (e.g. policy brief), identification of knowledge gap/knowledge cluster, possible interactive database of existing evidence
Specific expertise required	Topic expert