ECHO

ENGAGING CITIZENS IN SOIL SCIENCE:
THE ROAD TO HEALTHIER SOILS

Deliverable 1.4

Monitoring and Evaluation Framework

version M12

Co-funded by the European Union

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Project information

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Short description of the deliverable

This deliverable introduces the Monitoring and Evaluation (M&E) Framework for the ECHO project, encapsulating the systematic methodologies adopted to assess the effectiveness and impact of the project's diverse activities. At its core, the framework is designed to ensure that every component of the project aligns with the strategic objectives laid out in the grant agreement, thus enhancing overall success and sustainability. It provides a comprehensive overview of the performance indicators and evaluation methods that span the entire project, from individual work packages to overarching outcomes, ensuring a detailed and robust approach to monitoring both internal dynamics and external impacts.

The framework's methodological approach blends quantitative and qualitative techniques to allow a nuanced understanding of the project's effects within its operational context. This first version (M12) of the M&E framework will be updated by future iterations—specifically deliverables D1.5 (M32) and D1.6 (M42)—to incorporate lessons learned and adapt to evolving project dynamics. These updates are part of our commitment to continuous improvement, reflecting the collaborative efforts of all project partners and stakeholders.

Versioning and contribution history

Version	Date	Modified by	Notes
0.1	29/04/2024	Francisco Sanz	Draft version
0.1.1	07/05/2024	Olga Huerta	Draft version
0.2	18/05/2024	Francisco Sanz	Ready for revision
0.3	29/05/2024	Tanja Mimmo, Roy Neilson, Claudia Cappello, Olga Huerta	Revision
1.0	31/05/2024	Alba Peiro, Francisco Sanz	Final version

Foreword

Soil is a vital, yet often disregarded, resource that supports life on Earth by providing the foundation for agriculture, forests, and various other natural ecosystems. However, soil degradation is a growing concern around the world, and it can have severe consequences for our planet like reduced crop yields, increased greenhouse gas emissions, and decreased biodiversity. The ECHO project aims to prevent this by bringing together citizens and volunteer scientists from around Europe to work towards a common goal of protecting and preserving our soils, thus contributing to the transition towards healthy soils of the EU Mission: "A Soil Deal for Europe".

ECHO will generate new data on the health status of EU soils, complementing existing soil mapping and monitoring in EU Member States and Scotland, including the EU Soil Observatory (EUSO). The project will develop and deploy 28 tailor-made citizen science initiatives across EU Member States and Scotland, taking into account different land-uses, soil types, and biogeographical regions, as well as stakeholder needs. With 16 participants from across Europe, including 10 leading universities and research centres, 4 SMEs, and 2 Foundations, under the coordination of the Free University of Bolzano-Bozen, ECHO will assess 16,500 sites in different climate and biogeographic regions to achieve its ambitious goals.

The project aims to engage citizens in protecting and restoring soils by building their capacities and enhancing their knowledge. Citizens will thereby not only actively contribute to the project's data collection but also promote soil stewardship and foster behavioural change across the EU. ECHOREPO, a long-term open access repository with a direct link to the EUSO, will make citizen science data available for exploitation not only by scientists but also by citizens, policy makers, farmers, landowners and other end-users, providing added value to existing data and other relevant soil monitoring initiatives. ECHOREPO will thus provide valuable information about the state of soil health in various regions, and help citizens make informed decisions about land use and conservation.

We believe that the ECHO project will have a significant impact on soil health and citizen engagement across Europe and become an important step towards protecting and preserving our soil for future generations. By working together, we can ensure that our soil remains healthy and productive, and that we continue to enjoy the many benefits it provides.

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Executive summary

This deliverable presents the Monitoring and Evaluation (M&E) framework devised for the ECHO project, delineating the systematic approach to assess the effectiveness and impact of the project's activities. Our objective is to ensure that the project aligns with the strategic goals specified in the grant agreement (GA), enhancing its overall success and sustainability.

We begin with an **introduction** that outlines the purpose and methodology of the M&E framework. This section establishes the foundation for the evaluation process, linking it directly to the project's overarching aims and ensuring a cohesive understanding across all project activities.

Following the introduction, we explore our **project's vision and success criteria**. This part of the framework interprets the objectives, results, and indicators provided in the GA, discussing their relevance in practical scenarios. It emphasizes the importance of these indicators in real-world applications, providing clarity on how success will be measured and perceived throughout the project lifecycle.

The **outcomes of a series of collaborative workshops** with project partners form the basis of the third section. These workshops have been instrumental in refining our understanding of how each identified indicator relates to specific Work Packages (WPs). Moreover, they have enabled us to identify new, vital indicators that are pivotal for measuring the success of each WP and the project as a whole.

In Section 4, we **categorize these indicators into four groups: i) science, ii) participant, iii) socio-ecological, and iv) knowledge, attitude, and behaviour indicators**. This classification aids in organizing the evaluation process, making it more efficient and targeted. Additionally, we align these indicators with the "A Soil Deal for Europe" mission in subsection 4.2.

Our discussion then shifts to the evaluation instruments we will employ. This subsection details the **various tools and methodologies** that will be utilized to capture and analyse data throughout the project's duration. By outlining these instruments, we ensure that all monitoring and evaluation efforts are robust, systematic, transparent, and capable of providing the necessary insights to guide project adjustments and improvements.

The framework also incorporates **a self-assessment and reflection process**, presented in Section 5. This process is crucial for fostering a culture of continuous improvement, enabling project teams to regularly assess their performance against the set objectives and make informed decisions based on empirical data.

Section 6 outlines the **time plan for our M&E activities**. This schedule is meticulously crafted to ensure that evaluation tasks are integrated seamlessly with project milestones, facilitating timely assessments and reports.

Lastly, Section 7 **addresses the ethical considerations involved in the project's execution**. Here, we detail the measures in place to uphold ethical standards and comply with data protection laws, ensuring that all project activities are conducted responsibly.

1 Introduction

This document presents the first version (M12) of the Monitoring and Evaluation (M&E) Framework for the ECHO project. Designed to ensure systematic assessment and alignment of all activities, this framework serves as a fundamental tool for tracking progress, ensuring accountability, and facilitating data-driven adjustments within our project operations.

The core aim of this M&E framework is to establish a comprehensive system for measuring the effectiveness and impact of project activities while monitoring the internal dynamics and performance of the project itself. By doing so, we can quantitatively and qualitatively assess the sustainability of outcomes and the effectiveness of the project's implementation.

Covering all essential aspects of the ECHO project, from individual work packages to overarching outcomes, the framework details the performance indicators and the methods for their evaluation. This structure ensures a thorough overview of expected outputs and the impacts we aim to achieve.

Our methodological approach combines quantitative and qualitative methods, allowing for a nuanced understanding of the project's effects within its operating context. The framework's development and implementation have been collaborative efforts, incorporating inputs from all project partners. This collaborative approach ensures that the framework is reflective of diverse perspectives and needs, which enhances its applicability and effectiveness.

As the project progresses, we plan to revise and update this M&E framework to incorporate lessons learned and respond to changing project dynamics. These revisions will be detailed in our future deliverables, D1.5 at month 32 and D1.6 at month 42, allowing us to continually refine our evaluation strategies and methods.

2 The vision: overarching success criteria

During the proposal phase, the consortium agreed on a set of objectives and corresponding success indicators to evaluate the project impact. To ensure clarity and alignment and considering that this deliverable will serve as a key reference for all partners, outlining what needs to be achieved in terms of indicators, we present the objectives and indicators that need to be achieved.

Table 1: *Indicators related with objective 1*

Objective 1: to engage citizens by increasing knowledge and improving their literacy, stimulating their interest and motivating them to protect and restore soils.		
Result 1: Pan-European map of target citizen groups	**Result 2:** Citizen engaged with soil health activities	**Result 3:** Soil stewardship across Europe
R1-1: A map of citizen groups covering 28 European countries will be created. **R1-2**: Each identified group is expected to involve at least 75 citizens.	**R2-1:** Targeted dissemination of project materials. **R2-2:** A minimum of 30 meetings to promote participation are expected to be held.	**R3-1:** 28 citizen science activities **R3-2:** 16500 participants **R3-3:** 20% participating in soil stewardship efforts. **R3-4:** 28 Co-creation workshops

	R2-3: workshops and targeted presentations, a minimum of 28 activities	

Beyond the numerical values presented in Table 1 ECHO will be successful in achieving this objective if:

- A large number of citizens possess knowledge about the importance of soil health.
- Citizens actively engage in our citizen science activities.
- People demonstrate a noticeable change in their behaviour towards soil treatment and protection.
- The public demonstrates improved understanding of soil-related concepts.

Table 2: *Indicators related with objective 2*

Objective 2: to empower citizens to understand the functioning and value of soils and to be capable of taking an active role in soil science		
Result 4: Citizen science platform	**Result 5:** Increased knowledge among citizens about soil health	**Result 6:** Increased knowledge about soil health amplifying scientific research
R4-1: User friendly toolbox. 500 Citizens involved. **R4-2:** Guidelines and protocols translated to 24 official languages.	**R5-1:** Pre/post attitude and knowledge surveys. 16500 surveys	**R6-1:** 28 citizen science activities **R6-2:** 8 indicators to be analysed in each sample

Beyond numerical values presented in Table 2, ECHO will be successful in achieving this objective if:

- Participants are confident and equipped with the knowledge to understand soil health, its importance, and how it functions.
- Citizen scientists actively participate in soil science activities, including data collection and analysis, contributing valuable insights to the scientific community.
- The public widely utilizes the citizen science toolbox and platform to conduct soil assessments and comprehend their outcomes.
- Citizens demonstrate a notable improvement in soil health knowledge, as evidenced by enhanced understanding and awareness observed in pre- and post-activity surveys.
- Citizens can make informed decisions regarding soil management and contribute to community planning processes, promoting sustainable practices and soil stewardship.

Table 3: *Indicators related with objective 3*

Objective 3: to enable citizens to take an active role in directly participating in decision-making on soil issues based on acquired knowledge		
Result 7: Long-term digital data repository	**Result 8:** Different end-users groups engaged	**Result 9:** Showcase the utility of citizen science data on soil health
R7-1: All the software stacks will be validated against the requirements.	**R8-1:** Number of end-users contacted: through a survey (200), through interviews (50)	**R9-1:** One focus group per consortium country to identify and engage current and potential end-users.

R7-2: User testing will engage at least five experts	**R8-2:** An engagement strategy and guideline document, downloads along by the end of the project (2000)	**R9-2:** EU-level workshop

Beyond numbers presented in Table 3, ECHO will be successful in achieving this objective if:

- We develop a user-friendly digital repository that adheres to FAIR principles, enabling citizens to access, interpret, and utilize soil health data.
- We identify and involve key stakeholders (e.g., farmers, scientists, policymakers) across Europe, ensuring the data collected is relevant and impactful.
- We promote knowledge dissemination and understanding of soil health through workshops, focus groups, and collaborative strategies, enabling informed decisions by the community.
- We demonstrate the utility of citizen science data in policymaking, showcasing benefits such as cost savings and improved decision-making to encourage widespread adoption.

In Table 4, Table 5, Table 6 y Table 7, we outline the results expected to be achieved categorized by project outcomes.

Table 4: *Indicators related with outcome 1*

Outcome 1	Significantly increased public awareness of the value of soil
Results (0 y)	**RO1-1:** Minimum numbers of participants: 16500, among which 40-45% of female participants, 30-35% of students/young people, 20% stakeholders **RO1-2:** 15000 followers on ECHO's social media accounts

Table 5: *Indicators related with outcome 2*

Outcome 2	Citizens are empowered to take an active role in science and increasing the knowledge base on soils by monitoring and gathering data on soil biodiversity and becoming more aware of the importance of soils and the soil food web in their daily lives
Results (0 y)	**RO2-1:** Soil biodiversity data provided by citizen science activities across Europe addressing different soil types and biogeographical regions (16500 entries in the dataset ECHOREPO). **RO2-2:** >20000 downloads of the training tools from the website. **RO2-3:** Direct contacts with school and other organisations/associations that want to participate

Table 6: *Indicators related with outcome 3*

Outcome 3	Greater availability of local scale data on soil health. This will expand and complement established soil databases to support critical landscape decisions and policy development
Results (0 y)	**RO3-1:** Soil sampled from 16500 sites assessing 8 soil health indicators – large scale soil health assessment including large scale molecular analysis (bacterial and fungal diversity) and heavy metal monitoring. **RO3-2:** >8 papers published based on project data. **RO3-3:** >800 citations of the dataset/other elements related to ECHO

Table 7: Indicators related with outcome 4

Outcome 4	The EU Soil Observatory scope is enlarged and populated with citizen science data
Results (0 y)	**RO4-1:** Harmonized EU-wide ECHO data support together with EUSO soil perspectives relevant for the EU soil strategy, the Common Agricultural Policy (CAP), Zero Pollution Action Plan and Sustainable Development Goals (SDGs). **RO4-2:** >20000 citizen scientists using ECHO technologies. **RO4-3:** >5000 data accessed through ECHOREPO. **RO4-4:** +4 services integrated into the European Open Science Cloud (EOSC)

Additionally, the GA includes the following indicators related to communication and dissemination:

- **CI1:** >15000 visitors and page views
- **CI2:** 4 press releases for the duration of the project
- **CI3:** > 800 X followers
- **CI4:** > 300 subscribed to LinkedIn
- **CI5:** 2 newsletter/year, totaling 500 views year
- **CI6:** 2 videos (2-3 minutes) and 4 shorter clips (60 seconds), 100.000 views each video
- **CI7:** 10 posts/month
- **CI8:** 8 scientific papers
- **CI9:** 2 outreach articles/year
- **CI10:** > 40 attendants/event

3 Work package success criteria

Following the comprehensive list of indicators outlined in the previous chapter, a detailed examination of these indicators was conducted for each WP within the ECHO project. Ibercivis Foundation led individual sessions with each WP coordinator and main contributors to closely align each WP's tasks and resources with our goals. The Logic Framework Approach (LFA) was used as a structured methodology to assess the effectiveness of the planned activities in achieving desired changes. Originally utilized in development program design and evaluation, LFA has also been widely adopted for scientific and technology deployment programs, serving as a tool for objective-driven planning and systematic analysis across large-scale projects.

Ibercivis Foundation adapted the LFA specifically for the ECHO project, establishing a tailored template to facilitate structured dialogue among all stakeholders. This adaptation has proven instrumental in identifying and addressing issues early on, refining project objectives, tailoring activities, fostering a cohesive approach, and enhancing implementation efficiency.

For the ECHO project, we introduced a template that consolidates outputs and impacts. In later discussions with ECHO partners, as detailed in the indicator framework, we will revisit the traditional divisions of output, outcome, and impact, now redefined as output, short-term outcome, and long-term outcome to enhance clarity and strategic focus.

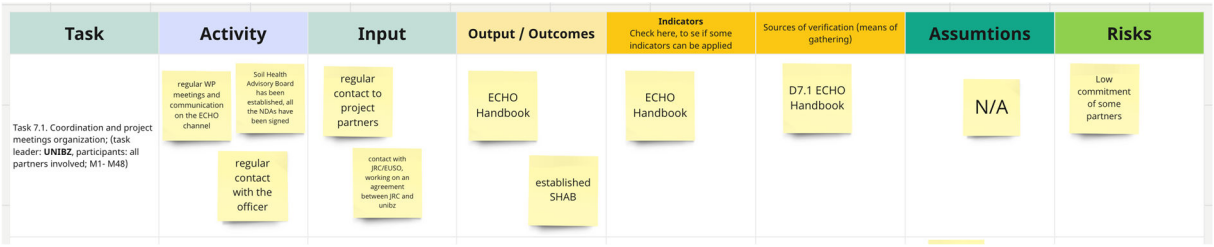

Figure 1: *Framework used to analyze WP activities*

Figure 1 shows the template that served as a framework for reviewing, discussing, and clarifying all relevant elements within each individual ECHO WP. Initially, the Ibercivis Foundation evaluation team populated the template with information from the description of work taken from the GA. Subsequently, this content was collaboratively refined and updated through discussions with the WP leaders. Beyond the matrix itself, these sessions also focused on identifying and articulating the key impacts anticipated from each WP. The results are presented below.

3.1 WP1 – Enabling high-impact citizen science for soil monitoring

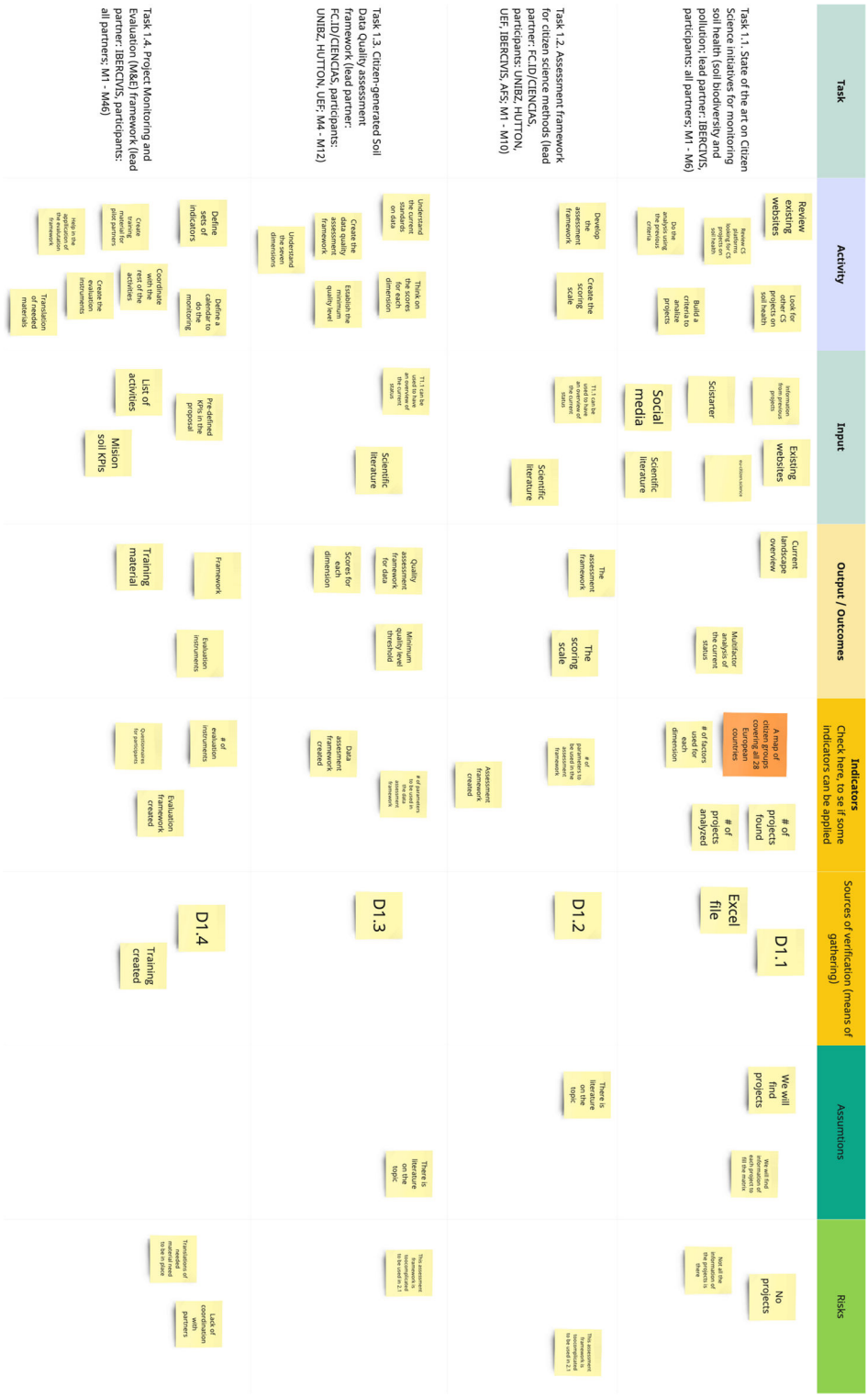

Figure 2: *WP1 analysis*

Figure 2 illustrates the outcomes of the analysis performed by participants in WP1 with a focus on the viewpoint of its coordinator, the Ibercivis Foundation. This analysis is crucial as it encapsulates the collaborative efforts and insights gained from the initial phase of the project. WP1 serves as a foundational element in our broader project strategy, highlighting the importance of cohesive planning and participant engagement from the outset.

The objectives of WP1 are multifaceted and ambitious. Firstly, it aims to identify existing citizen science projects focused on soil monitoring and to gather and meticulously dissect information that is pertinent to the ECHO project. This involves a detailed examination of the methodologies and technologies employed, the scientific data collected, and the engagement practices utilized. Secondly, WP1 is tasked with developing and continuously refining assessment frameworks throughout the duration of the project. These frameworks are designed to cover several critical aspects: i) methodologies for citizen science in soil monitoring, incorporating technological support devices; ii) data quality control standards applicable to the methodologies that will be later deployed in pilot projects; iii) a comprehensive approach to monitor and assess both intrinsic factors (related to project design and processes) and extrinsic factors (related to project outcomes).

The completion of Tasks 1.1, 1.2, and 1.3 within the first year of the project sets a solid foundation for the subsequent phases. These tasks are instrumental in establishing the groundwork for the entire project, as evidenced by the development of the state of the art, both assessment frameworks (one for citizen science and the other for data), and the project monitoring and evaluation framework. These indicators are essential for ensuring that each component of the project is not only completed but also aligns with the overarching goals and expected outcomes, setting a benchmark for success and continual improvement. Thus, the following indicators were added:

- **WI1-1:** State of the art on citizen science initiatives for monitoring soil health – Status: completed.
- **WI1-2:** Assessment framework for citizen science methods– Status: completed.
- **WI1-3:** Citizen-generated soil data quality assessment framework– Status: completed.

3.2 WP2 – Citizen science platform

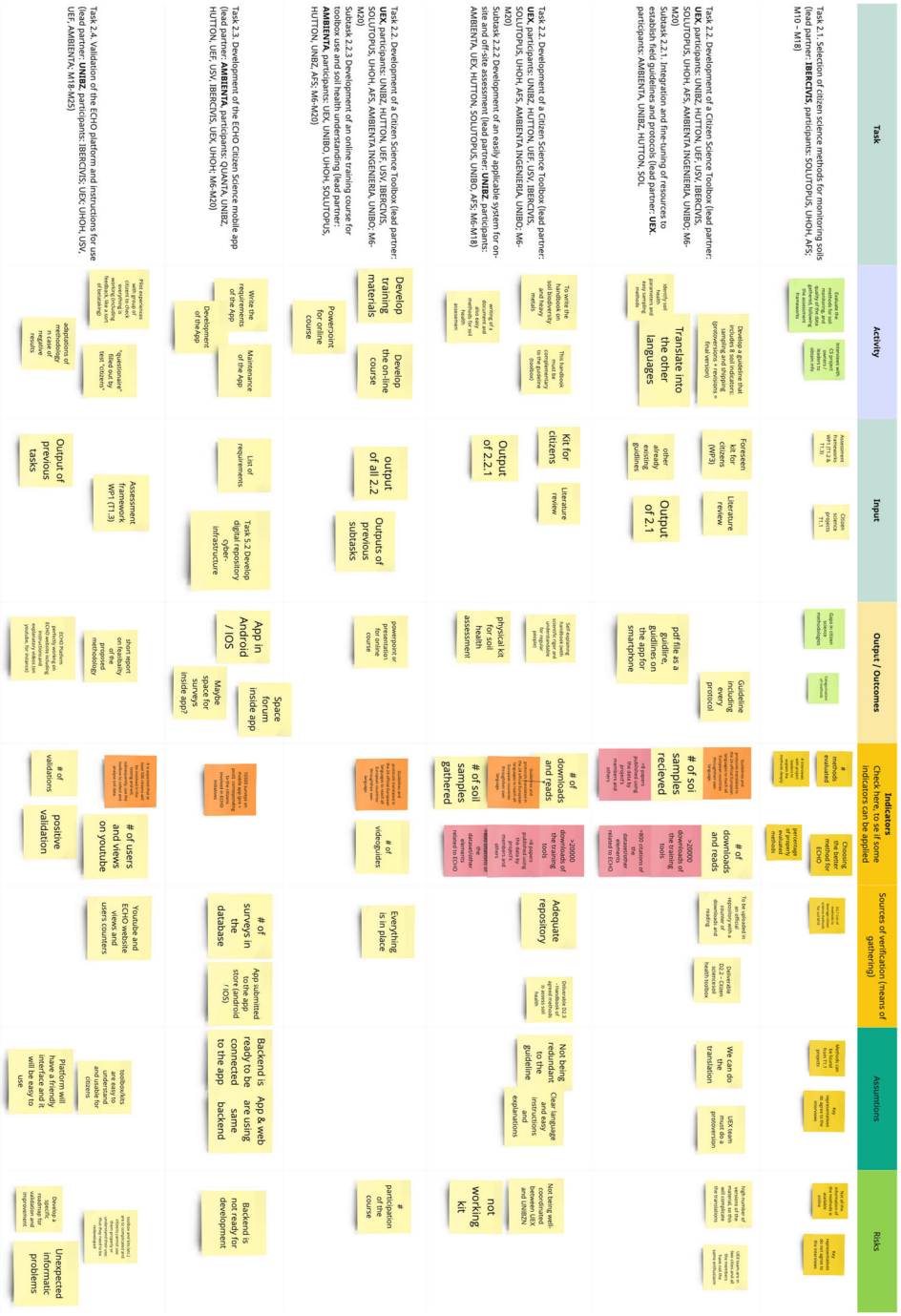

Figure 3: *WP2 analysis*

Figure 3 represents the analysis conducted by participants of WP2, particularly reflecting the perspective of the UEX coordinator and the leaders of each task.

The primary objective of this WP is to develop and validate content for an open access citizen science platform. This includes field guidelines, a toolbox comprising soil monitoring and assessment protocols

to support the collection of robust citizen science soil data, and a gamified training module outlining EU land uses, descriptions of landscapes, and soil threats in a clear and simplified manner. The citizen science platform will be integrated with the ECHO mobile app and website.

As indicated in the input column, the activities in this WP depend heavily on WP1 and WP5 for the development of the app. This WP directly contributes to some existing indicators, such as the number of downloads of the training tools, citations of other created elements, and the publication of papers. Additionally, other indicators may be useful to assess the success of this WP, such as the number of methods evaluated, the number of interviews with other soil project leaders, the number of downloads and reads of the created guidelines, and the number of unique viewers and views of the created videos on YouTube.

Although several risks have been identified, none that are significant are extrinsic to the project.

New selected indicators identified from this analysis were:

- **WI2-1:** Number of methods evaluated for citizen science and soil health.
- **WI2-2:** Number of interviews with project leaders to explain the methods in depth.
- **WI2-3:** Number of video guides created.
- **WI2-3:** Number of viewers on YouTube.

3.3 WP3- Development and coordination of citizen science initiatives

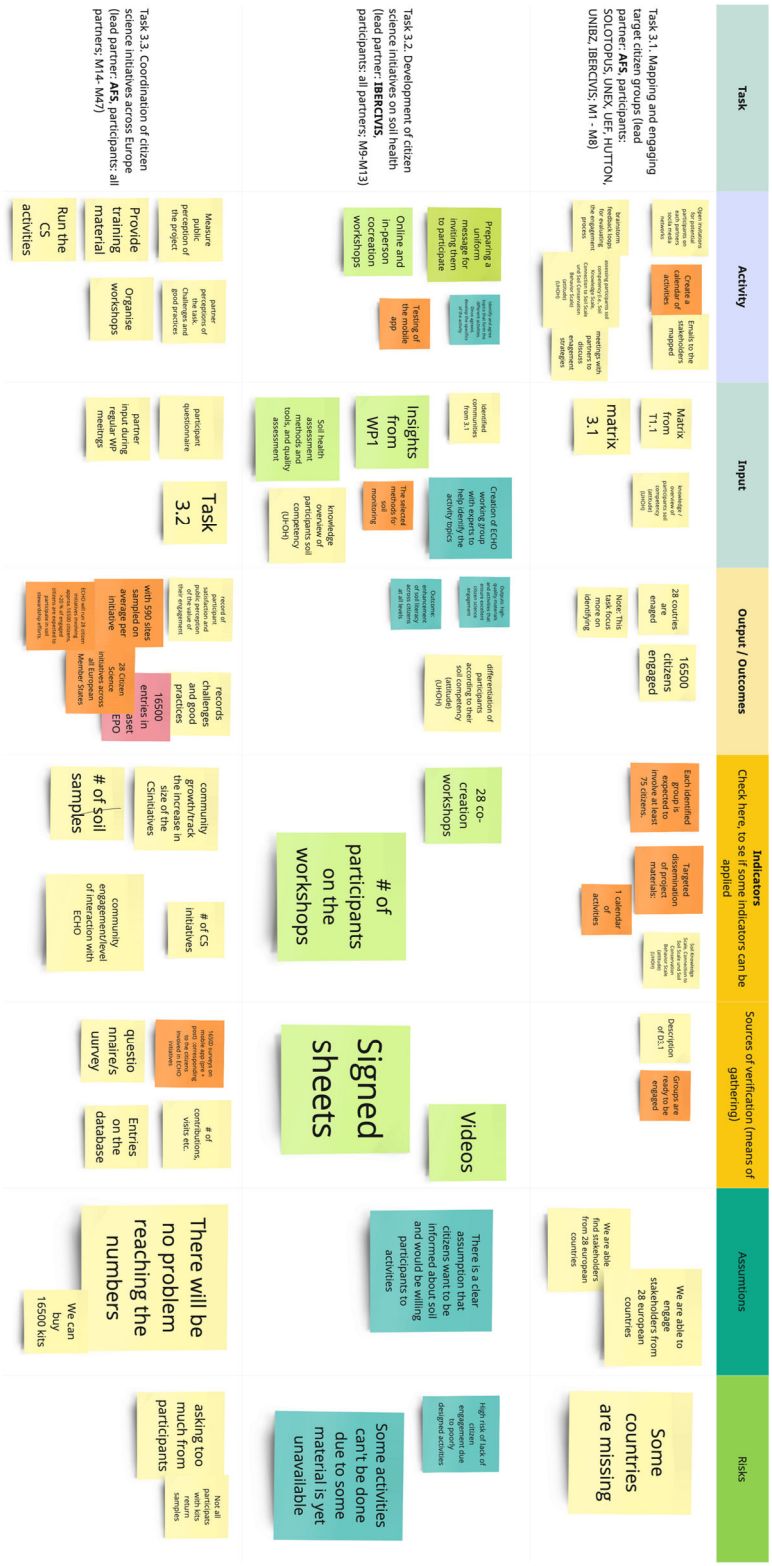

Figure 4: *WP3 analysis*

Figure 4 represents the analysis conducted for WP3. Similar to other exercises, we explored the importance and detailed activities of the tasks within WP3, and examined both existing and new indicators that can be used to monitor the quality of WP delivery.

The overarching goal of this WP, led by AFS, is to set up and deliver participatory citizen science initiatives focused on soil health across Europe. This goal will be achieved through the following objectives: a) mapping and engaging target citizen groups in the project; b) setting up and facilitating the development of citizen science initiatives on soil health in all Member States and Scotland; c) developing and coordinating the activities of soil health citizen science initiatives.

Therefore, this WP will encompass all activities related to the execution of citizen science initiatives, and thus, it will directly contribute to the related indicators. Additionally, other indicators emerged as relevant when analysing the quality of project execution, such as the number of participants in workshops, establishing a timeline of activities and measuring the level of engagement and interaction with ECHO by the participants and other similar initiatives.

Regarding risks, those associated with any citizen science project were identified, such as not achieving a high rate of return and, on the other hand, not exerting sufficient motivation on participants. Ensuring an attractive design for the activities was identified as essential.

New selected indicators identified from this analysis were:

- **WI3-1:** Number of participants on the workshops.
- **WI3-2:** Level of community engagement.

3.4 WP4 – Citizen Science generated data uses and values

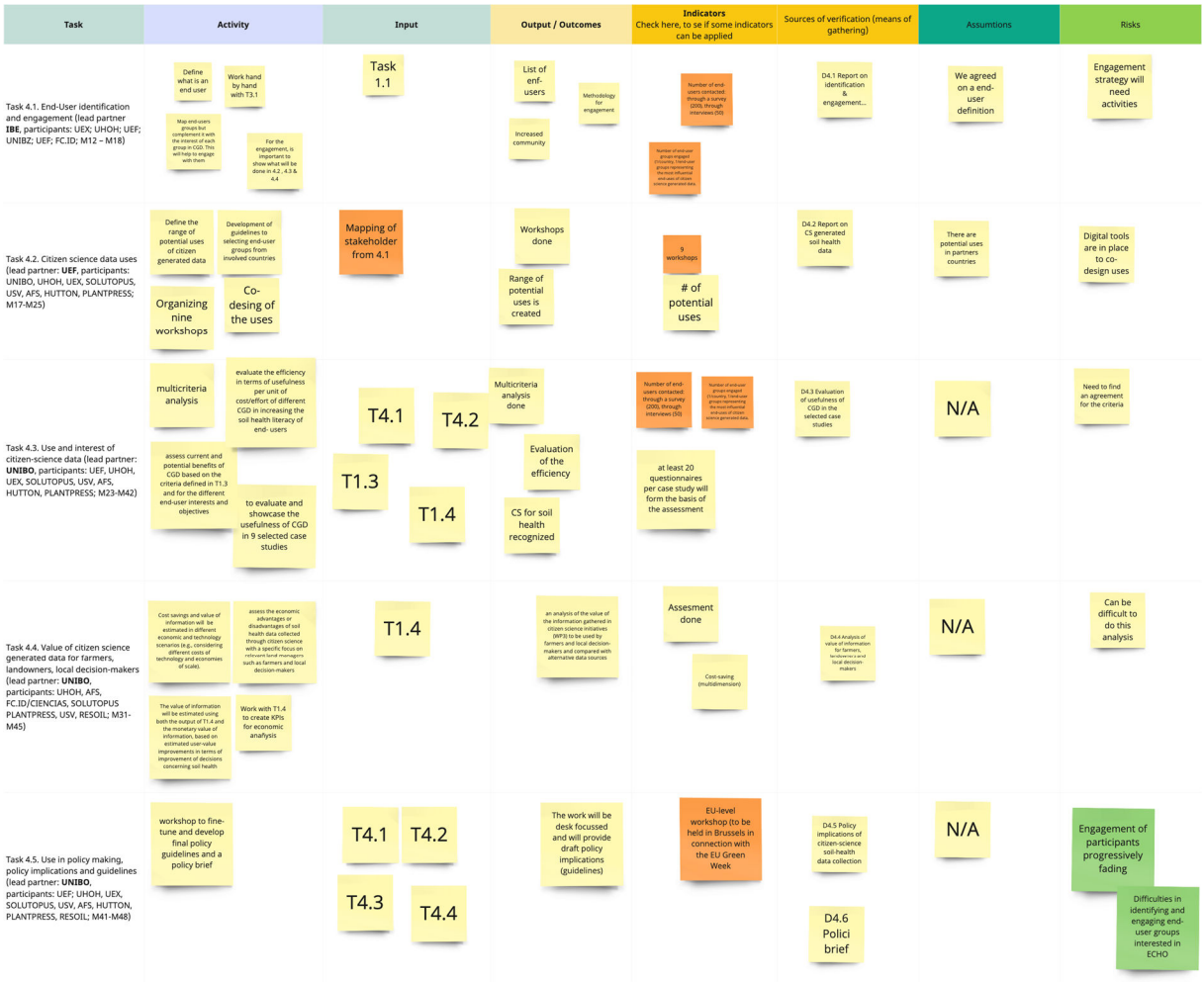

Figure 5: *WP4 analysis*

Figure 5 represents the analysis conducted for WP 4. The main goal of this WP is to derive significant added value from Citizen Science initiatives by exploring the interest in and value of citizen-generated data (CGD) for end-users. This objective is subdivided into four specific sub-objectives: a) identifying and engaging end-users; b) assessing the interest in data use and collaboration among different end-users; c) evaluating the usefulness and value of information for different end-users; and d) drawing policy implications from CGD on soil and biodiversity, along with developing guidelines.

Furthermore, Task 4.4 of this WP aligns closely with Task 1.4 by defining indicators that will measure the economic impact of the project. These indicators are yet to be included in this deliverable and will be included in future revisions of T1.4.

3.5 WP5- Participatory digital technologies

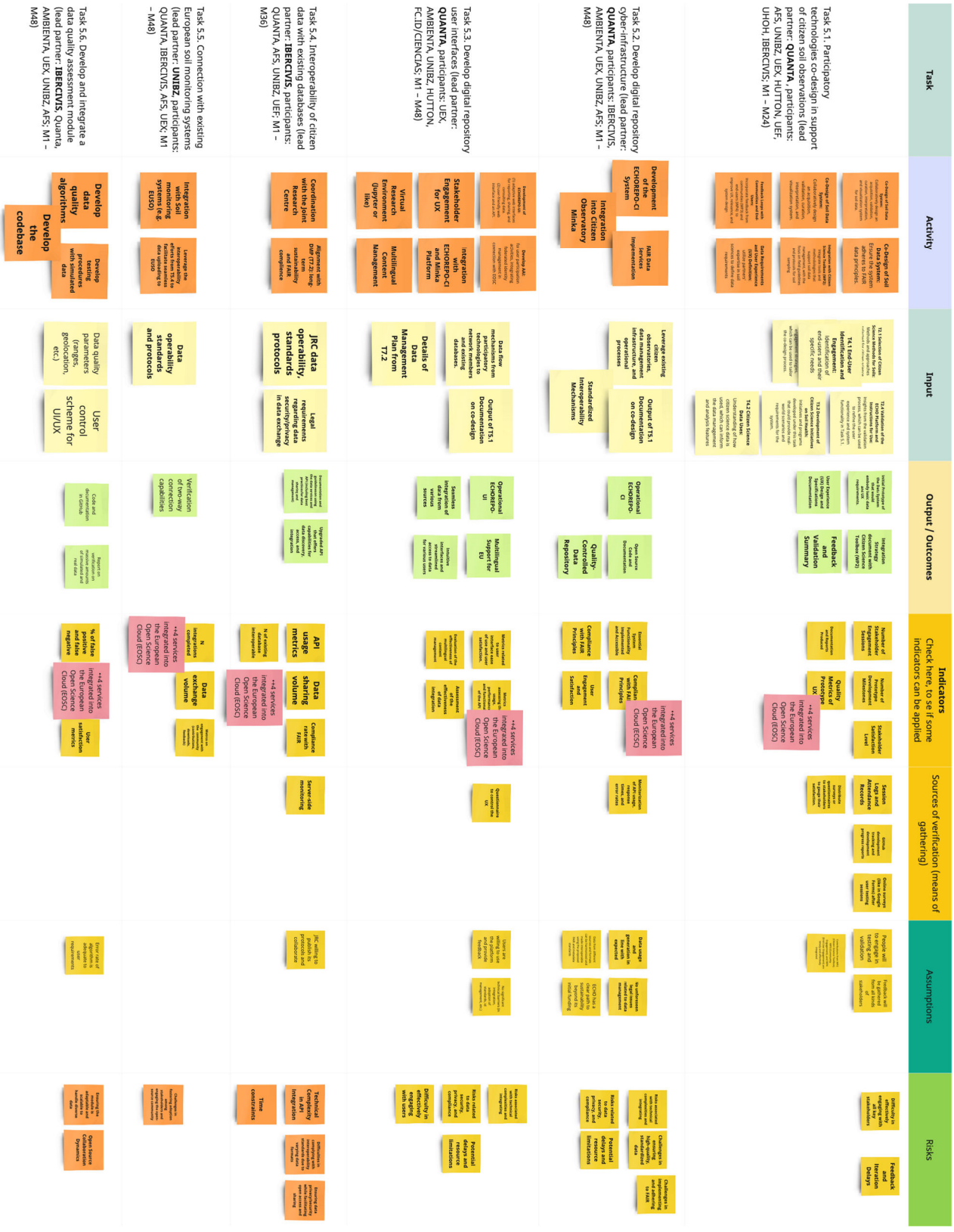

Figure 6: *WP5 analysis*

Figure 6 presents the analysis conducted for WP5, led by QUANTA. The primary aim of this WP is to establish an end-to-end data pipeline, from data acquisition to visualization, and to create a long-term repository for data generated from citizen science initiatives. This repository will be scalable and integrated with European Soil Databases, enhancing soil data generation and interpretation capabilities across Europe.

WP5 focuses on developing technologies for participatory platforms, ensuring data and metadata interoperability by adopting FAIR principles, and linking participatory technologies with European Soil Databases.

As this WP supports the activities from WP4 and WP3, it will aid in achieving the indicators related to those WPs. Moreover, WP5 will generate indicators that are metrics of website/interface/database usage that are beneficial not only for the success of this WP but also for the entire project.

Additional relevant indicators include compliance with FAIR principles. Regarding risks, the main concerns include potential delays, dependencies on other initiatives, and time constraints.

New selected indicators identified from this analysis were:

- **WI5-1:** Number of stakeholder engagement sessions.
- **WI5-2:** Compliance with FAIR principles.
- **WI5-3:** User engagement and satisfaction metrics for all services deployed.
- **WI5-4:** Metrics assessing the usage of the API.
- **WI5-5:** Number of times the ECHO platform is accessed.

3.6 WP6- Dissemination & communication

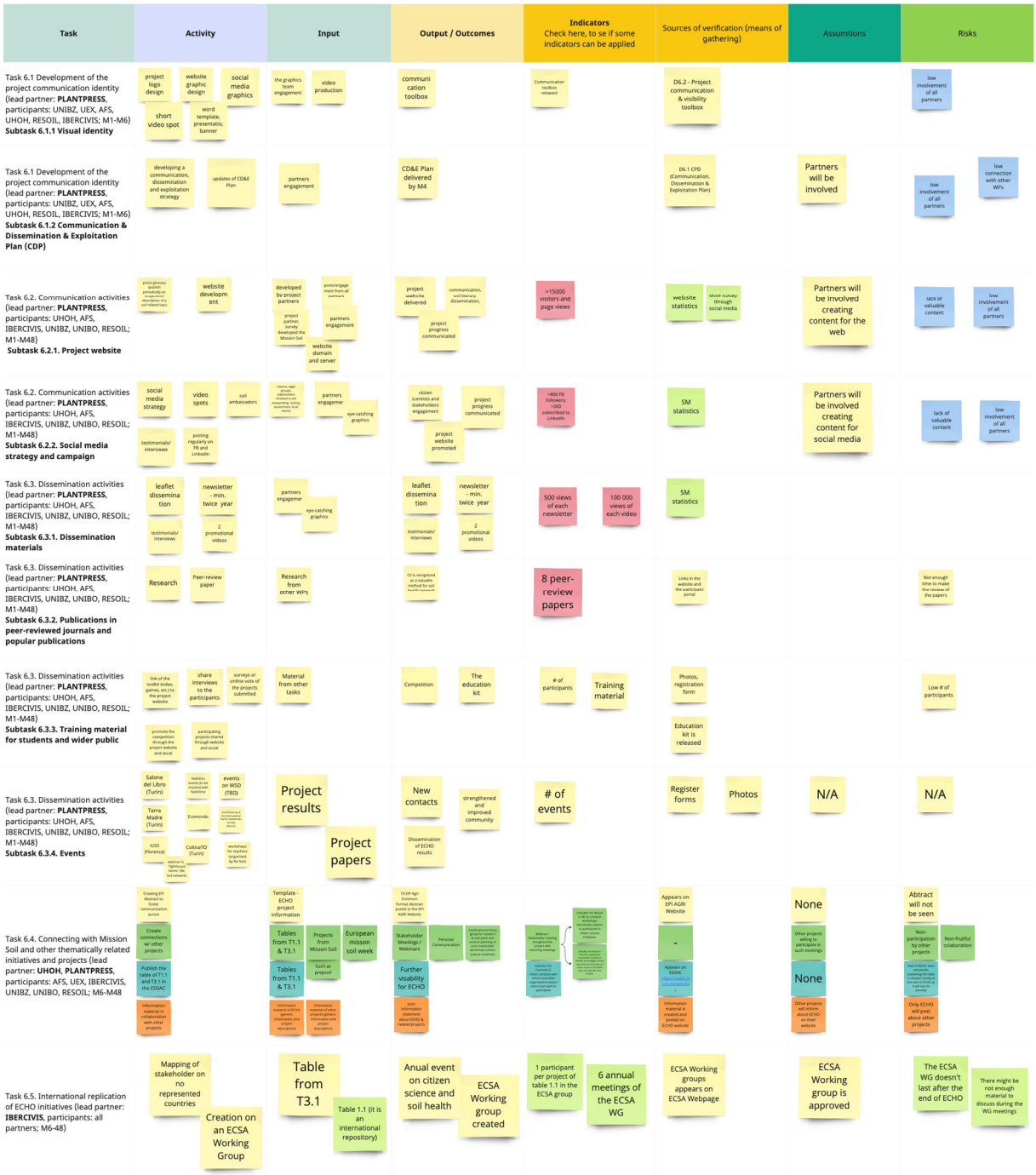

Figure 7: *WP6 analysis*

Figure 7 represents the analysis of WP6, led by PlantPress. This WP maximizes the impact of ECHO through tailored dissemination and communication in support of the other WPs. The objective is to enhance the visibility of project activities, results, and deliverables, and to highlight project achievements.

The communication activities of ECHO are designed to: a) support ECHO partners in communicating and disseminating their work, and to create consistency between local dissemination and project level communication activities; b) increase ECHO project visibility; c) share and communicate the project's objectives and results; d) establish connections with other projects and initiatives of the mission to build a foundation for a European community on soil health.

Consequently, WP6 is pivotal to the exploitation process as it drives the dissemination of knowledge and results to various stakeholders, including the scientific community, industry, policy makers, and the public.

Therefore, this WP will contribute to the delivery of almost all indicators. Its performance will be measured using the established indicators outlined in the GA, eliminating the need for additional indicators. In terms of risks, the primary concern identified is the potential failure to fully engage all consortium partners in the communication tasks.

3.7 WP7- Project management and coordination

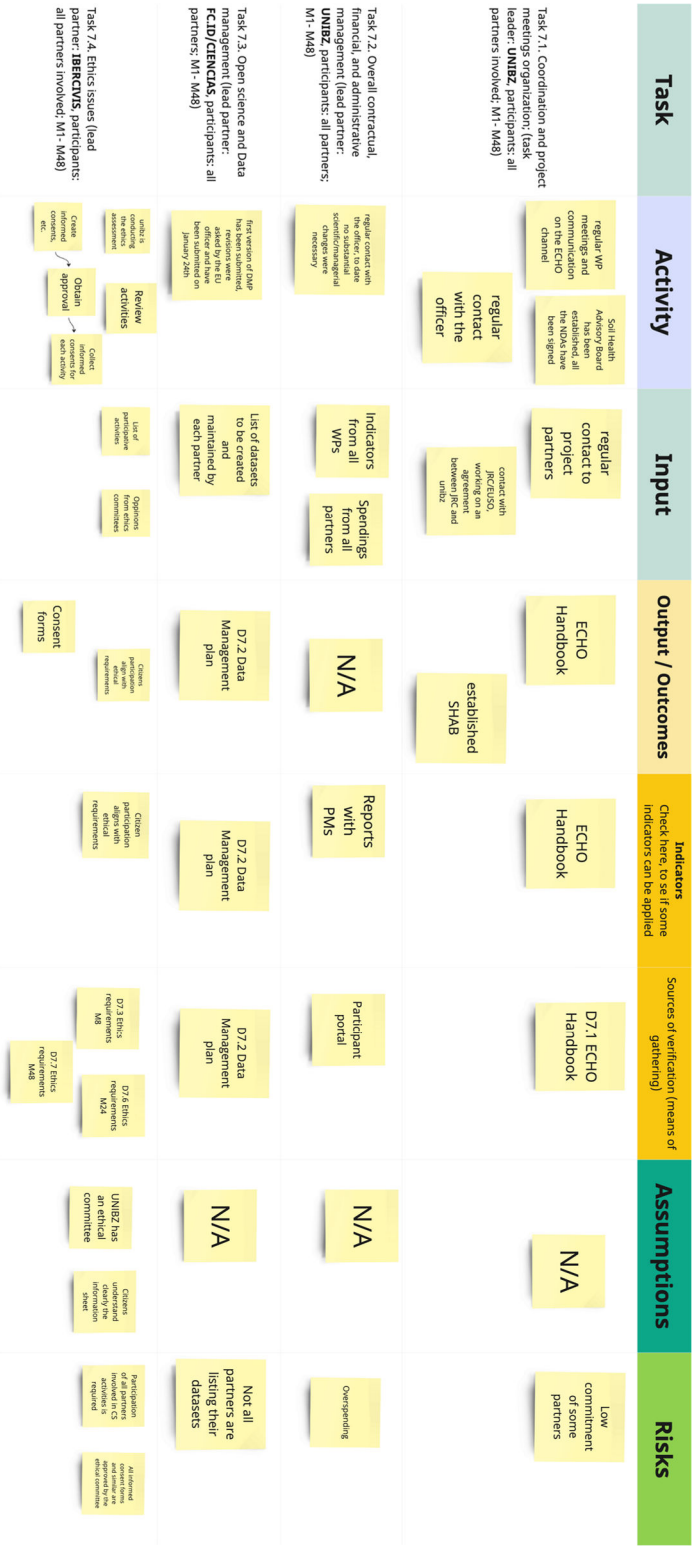

Figure 8: *WP7 analysis*

Figure 8 is the result of the analysis performed for WP7, led by UNIBZ. The overarching objective of WP7 is to ensure the smooth operation and delivery of the project, focusing on the following specific objectives to: a) coordinate and supervise the project's research and innovation activities according to the work plan and available resources, while also monitoring and ensuring the quality and timing of project deliverables; b) prevent and resolve potential conflicts and ensure effective risk management; c) handle the overall administrative, legal, and financial management and reporting of the project, as well as liaison with the EU; d) develop and update a data management plan that includes special provisions for Open Access and FAIR project data management; e) ensure that the project activities, especially those involving citizens, comply with ethics requirements and GDPR.

Thus, by definition, WP7 is not directly responsible for achieving the indicators defined at the proposal level, although it indirectly supports all of them. Nevertheless, we have considered it appropriate to perform this analysis on WP7 as it also helps to identify potential risks and assumptions.

4 Indicator framework

The indicator framework for the ECHO project is comprised of two essential elements. Firstly, there are the indicators, which are categorized into four distinct groups: i) science indicators, ii) participant indicators, iii) socio-ecological and economic indicators, and iv) knowledge, attitude, & behavior indicators. Each category serves a specific purpose and collectively, they encompass the comprehensive metrics used to assess the project's impact and effectiveness.

Secondly, the framework emphasizes the critical importance of having robust tools to evaluate these indicators. It is not enough to merely identify and categorize the indicators; effective mechanisms must also be in place to accurately measure and analyze them. This ensures that the project's objectives are met and that the findings are reliable and actionable.

This chapter provides a systematic review of the indicators. It begins by defining each category, explaining the significance of the indicators within each category and how they contribute to the overarching goals of the ECHO project. Following the classification, the chapter proceeds to explore in depth the various tools and methodologies employed by the ECHO project to evaluate these indicators.

In the concluding section of this chapter, we will address the diverse instruments utilized for the evaluation of the indicators. As is customary in such assessments, our approach will incorporate both quantitative and qualitative methods. These methodologies are selected to complement each other, ensuring a holistic evaluation framework that captures both measurable data and nuanced insights.

4.1 Classification of the indicators

4.1.1 Science Indicators

Definition: Science indicators in the ECHO project encompass measures related to scientific research and its outputs. These indicators include the number of soil samples collected across different regions,

data generated on soil health indicators, the number of scientific papers published using data from the project, citations of this research, and the frequency of data access from repositories like ECHOREPO.

Importance of measurement: Science indicators are fundamental for evaluating the scientific rigor and impact of ECHO. They provide essential metrics that demonstrate the project's contribution to the field of soil science. By tracking these indicators, stakeholders can assess how effectively the project is generating new knowledge, integrating with existing scientific frameworks, and pushing the boundaries of what is known about soil ecosystems. Additionally, these indicators help in validating the methodologies used in ECHO, ensuring that they meet scientific standards and contribute reliable data for global discussions on soil health and management.

4.1.2 Participant Indicators

Definition: Participant indicators in ECHO track the engagement and demographics of individuals involved in the project. These include metrics such as the total number of citizen scientists, the demographic breakdown (e.g., age, gender, education level), geographic distribution of participants, level of involvement (e.g., one-time participants vs. ongoing contributors), and participant feedback on their experience.

Importance of measurement: These indicators are crucial for understanding the reach and inclusiveness of the project. They help ECHO partners to ensure that the project is accessible to a diverse audience and that it provides meaningful opportunities for community involvement. Moreover, participant indicators help gauge the effectiveness of outreach and education efforts, indicating whether the project is successful in attracting and retaining volunteers. This is particularly important for maintaining a robust and motivated participant base that feels valued and is likely to contribute to long-term project sustainability and success.

4.1.3 Socio-Ecological and Economic Indicators

Definition: In ECHO, socio-ecological and economic indicators measure the broader impacts of the project on communities and ecosystems. These can include the adoption of new soil health practices influenced by ECHO's findings, changes in local biodiversity because of improved soil management, economic assessments of increased agricultural productivity due to healthier soils, and overall improvements in community well-being and resilience.

Importance of measurement: These indicators bridge the gap between scientific research and practical application. They provide insight into how the project's findings are translated into actionable changes that benefit ecological systems and local economies. Measuring these impacts is vital for validating the effectiveness of ECHO in promoting sustainable soil management practices and enhancing environmental stewardship. Furthermore, these indicators can help in advocating for policy changes, securing funding, and fostering partnerships that enhance the project's reach and impact.

4.1.4 Knowledge, Attitude, & Behaviour Indicators

Definition: Knowledge, attitude, and behaviour indicators in the ECHO project focus on the educational outcomes and changes prompted by the initiative. Knowledge indicators might include measures of increased understanding of soil health among participants and the public. Attitude indicators could

look at shifts in how people value soil conservation. Behaviour indicators would monitor changes in participants' soil protection and restoration practices.

Importance of measurement: These indicators are critical for assessing the transformative impact of ECHO on individual and community levels. By tracking changes in knowledge, attitudes, and behaviours, the project can evaluate its success in educating the public about the importance of soil health and in motivating actions that lead to sustainable environmental practices. Such metrics are essential for demonstrating the efficacy of educational components within ECHO and for refining strategies to enhance public engagement and impact.

Given the significance of these indicators, it becomes necessary to introduce three new indicators that measure soil knowledge, connectedness to soil, and sustainable soil behaviour at preliminary, intermediate, and post stages of citizen participation. These indicators align with the tailor-made citizen science initiatives implemented by ECHO across European Member States plus Scotland, which aim to enhance citizens' understanding of and attitudes towards soil health, and to empower them to actively engage in soil protection and restoration efforts. Our outcome-based evaluation is designed to gauge the impact of these initiatives on participants' intellectual and motivational abilities related to soil. Specifically, we seek to assess the effectiveness of these initiatives in eliciting changes in participants' knowledge, connectedness, and behaviour, using these specific and measurable indicators to guide the evaluation process.

- **KABI-1: Soil knowledge:** Increase in participants' understanding of various aspects of soil and soil health, including soil composition, properties, functions, biodiversity, erosion, contamination, and soil management, among others.
- **KABI-2: Connectedness to soil:** Enhancement of participants' connection with soil (i.e., the extent to which individuals include soil as part of their identity), including emotional, cognitive and behavioural aspects.
- **KABI-3: Sustainable Soil Behaviour**: Adoption of practices and behaviours by participants that contribute to the protection and restoration of soils over time.

4.1.5 Overall vision of the indicators

Table 8 illustrates how each project indicator contributes to various dimensions of the initiative, specifically categorized under Project Internal Monitoring Indicators (PIMI), Science Indicators (SI), Participant Indicators (PI), Socio-Ecological and Economic Indicators (SEEI), and Knowledge, Attitude, & Behaviour Indicators (KBI).

Table 8: *Contribution of the indicators to each dimension*

Indicator cap	PIMI	SI	PI	SEEI	KBI
R1-1: A map of citizen groups covering all 28 European countries will be created.	✓	✓	✓✓	✓	✓
R1-2: Each identified group is expected to involve at least 75 citizens.	✓		✓✓	✓	✓
R2-1: Targeted dissemination of project materials.	✓		✓✓		✓
R2-2: A minimum of 30 meetings to promote participation are expected to be held.	✓✓		✓✓		✓

Indicator cap	PIMI	SI	PI	SEEI	KBI
R2-3: Workshops and targeted presentations, a minimum of 28 activities.	✓✓		✓✓		✓
R3-1: 28 citizen science activities.	✓✓	✓	✓✓		✓
R3-2: 16500 participants.	✓✓	✓	✓✓		
R3-3: 20% participating in soil stewardship efforts.	✓		✓✓	✓	✓
R3-4: 28 Co-creation workshops.	✓✓		✓✓		✓
R4-1: User friendly toolbox. 500 Citizens involved.	✓		✓✓		
R4-2: Guidelines and protocols translated to 24 official languages.	✓✓		✓✓	✓	✓
R5-1: Pre/post attitude and knowledge surveys (16500 surveys).	✓		✓	✓	✓✓
R6-1: 28 citizen science activities.	✓✓	✓	✓✓		✓
R6-2: 8 indicators to be analysed for each sample.	✓	✓✓	✓		
R7-1: All software stacks will be validated against the requirements.	✓✓	✓✓	✓		
R7-2: User testing will engage at least five experts.	✓✓	✓	✓		
R8-1: Number of end-users contacted: through a survey (200), and through interviews (50).	✓✓		✓	✓	✓
R8-2: An engagement strategy and guideline document, downloads by the end of the project (2000).	✓✓		✓✓		
R9-1: One focus group per consortium country to identify and engage current and potential end-users.	✓		✓✓		✓
R9-2: EU-level workshop.	✓✓	✓	✓✓	✓	✓
RO1-1: Minimum numbers of participants: 16500, among which 40-45% of female participants, 30-35% of students/young people, 20% stakeholders.	✓✓	✓	✓✓	✓	✓
RO1-2: 15000 followers on ECHO's social media channels.	✓	✓	✓✓		✓
RO2-1: Soil biodiversity data provided by citizen science activities across Europe addressing different soil types and biogeographical regions (16500 entries in the dataset ECHOREPO).		✓	✓✓		
RO2-2: >20000 downloads of the training tools from the ECHO website.	✓		✓✓	✓	✓
RO2-3: Direct contacts with school and other organisations / associations that want to participate.	✓✓		✓✓		
RO3-1: 16500 sampled soil sites assessing 8 soil health indicators – large scale soil health assessment including large scale molecular analysis (bacterial and fungal diversity) and heavy metal monitoring.	✓	✓	✓✓		
RO4-1: Harmonized EU-wide ECHO data support together with EUSO soil perspectives relevant for the EU soil strategy, the Common Agricultural Policy (CAP), Zero Pollution Action Plan and Sustainable Development Goals (SDGs).	✓✓	✓✓	✓		
RO4-2: >20000 citizen scientists using ECHO technologies.	✓✓	✓	✓✓	✓	✓
RO4-3: >5000 data accessed through ECHOREPO.	✓✓	✓	✓✓		

Indicator cap	PIMI	SI	PI	SEEI	KBI
RO4-4: +4 services integrated into the European Open Science Cloud (EOSC).	✓✓	✓	✓		
CI1: >15000 website visitors and page views	✓✓		✓✓		
CI2: 4 press releases for the duration of the project	✓✓				
CI3: > 800 X (ex-Twitter) followers	✓✓		✓✓		
CI4: > 300 subscribed to LinkedIn	✓✓		✓✓		
CI5: 2 newsletter/year, totaling 500 views/year	✓✓		✓		
CI6: 2 videos (2-3 minutes) and 4 shorter clips (60 seconds), 100,000 views for each video	✓✓		✓		
CI7: 10 posts/month	✓✓		✓		✓
CI8: 8 scientific papers	✓✓	✓✓			
CI9: 2 outreach articles/year	✓✓	✓	✓	✓	✓
CI10: > 40 attendants/event	✓✓		✓✓		✓
WI1-1: State of the art on citizen science initiatives for monitoring soil health. Status: completed.	✓✓	✓✓	✓		
WI1-2: Assessment framework for citizen science methods. Status: completed.	✓✓	✓✓	✓		
WI1-3: Citizen-generated soil data quality assessment framework. Status: completed.	✓✓	✓✓	✓		
WI2-1: Number of methods evaluated for citizen science and soil health.	✓✓	✓✓	✓		
WI2-2: Number of interviews with project leaders to explain the methods in depth.	✓	✓	✓		
WI2-3: Number of video guides created.	✓		✓✓	✓	✓
WI2-3: Number of viewers on YouTube.	✓		✓✓	✓	✓
WI3-1: Number of participants to the workshops.	✓		✓✓		✓
WI3-2: Level of community engagement.	✓		✓✓	✓	✓
WI5-1: Number of stakeholder engagement sessions.	✓		✓✓	✓✓	✓
WI5-2: Compliance with FAIR principles.	✓✓	✓✓	✓		
WI5-3: User engagement and satisfaction metrics for all services deployed.	✓	✓✓	✓	✓	✓
WI5-4: Metrics assessing the usage of the API.	✓	✓✓	✓		
WI5-5: Number of times the ECHO platform is accessed.			✓✓		✓
KABI-1: Soil knowledge.	✓	✓	✓	✓	✓✓
KABI-2: Connectedness to soil.	✓	✓	✓	✓	✓✓
KABI-3: Sustainable Soil Behaviour.	✓	✓	✓	✓	✓✓

As the project progresses, WP 4 - 'Citizen Science Generated Data: Uses and Values' - will gain greater significance. This WP starting in Month 12, will necessitate the development of economic indicators to complement this table. Indeed, Task 4.4, 'Value of Citizen Science Generated Data for Farmers, Landowners, and Local Decision Makers,' will evaluate the economic benefits of soil health data collected through citizen science for the aforementioned stakeholders.

4.2 A soil deal for Europe

The ECHO project is committed to aligning its Monitoring and Evaluation (M&E) framework with the monitoring and evaluation framework established for the Soil Deal for Europe under Horizon Europe. This alignment ensures that ECHO's efforts contribute effectively to the overarching goals of improving soil health across Europe by 2030.

The Soil Deal for Europe emphasizes the importance of a robust M&E framework to track progress towards healthy soils within a network of living labs and lighthouses. This framework includes a comprehensive set of impact, outcome, and output indicators, designed to measure scientific, economic, environmental, and social dimensions. Key elements include definitions of soil health, specific soil health indicators, management indicators, baseline and aspirational targets, and detailed inputs, outputs, and outcomes.

Similarly, the ECHO project's indicators are designed to track a wide range of activities and outcomes related to citizen science, stakeholder engagement, and soil health monitoring. By aligning with the Soil Deal for Europe's framework, ECHO aims to ensure consistency and coherence in monitoring soil health initiatives, thereby contributing valuable data and insights to the broader mission.

Table 9 illustrates how the indicators align with the principles of the Soil Deal for Europe Implementation Plan.

Table 9: *Alignment of the indicators with the principles of the Soil Deal for Europe Implementation Plan*

Indicator	Alignment with Soil Deal for Europe Implementation Plan
R1-1: A map of citizen groups covering all 28 European countries will be created.	Supports the establishment of a comprehensive monitoring network for tracking soil health across Europe.
R1-2: Each identified group is expected to involve at least 75 citizens.	Supports widespread engagement and community-based monitoring efforts.
R2-1: Targeted dissemination of project materials.	Ensures that information reaches relevant stakeholders and contributes to soil health awareness.
R2-2: A minimum of 30 meetings are expected to be held.	Facilitates stakeholder engagement and collaborative efforts in soil stewardship.
R2-3: Workshops and targeted presentations, a minimum of 28 activities.	Promotes knowledge sharing and best practices for soil management.
R3-1: 28 citizen science activities.	Involves the public in hands-on monitoring and contributes to data collection.
R3-2: 16500 participants.	Enhances public involvement and supports grassroots soil health initiatives.
R3-3: 20% participating in soil stewardship efforts.	Demonstrates active citizen engagement in soil conservation.
R3-4: 28 Co-creation workshops.	Encourages collaborative innovation and stakeholder input in soil health strategies.
R4-1: User friendly toolbox. 500 Citizens involved.	Provides practical tools for community participation in soil monitoring.

Indicator	Alignment with Soil Deal for Europe Implementation Plan
R4-2: Guidelines and protocols translated into 24 official languages.	Ensures accessibility in soil health initiatives.
R5-1: Pre/post attitude and knowledge surveys. 16500 surveys.	Measures the impact of educational efforts on soil health awareness.
R6-1: 28 citizen science activities.	Reinforces public participation in scientific data collection and monitoring.
R6-2: 8 indicators to be analysed from each sample.	Provides comprehensive data for assessing soil health.
R7-1: All software stacks will be validated against the requirements.	Ensures the technical reliability of soil health monitoring tools.
R7-2: User testing will engage at least five experts.	Ensures the usability and effectiveness of the monitoring tools.
R8-1: Number of end-users contacted: through a survey (200), and through interviews (50).	Collects valuable feedback to refine soil health strategies
R8-2: An engagement strategy and guideline document, downloads by the end of the project (2000).	Supports widespread adoption and implementation of soil health practices.
R9-1: One focus group per consortium country to identify and engage current and potential end-users.	Enhances stakeholder engagement and identifies user needs for soil health initiatives.
R9-2: EU-level workshop.	Facilitates high-level discussion and collaboration on soil health strategies across Europe.
RO1-1: Minimum numbers of participants: 16500, among which 40-45% of female participants, 30-35% of students/young people, 20% stakeholders.	Ensures diverse and representative participation in soil health initiatives.
RO1-2: 15000 followers on ECHO's social media channels.	Increases public awareness and engagement with soil health topics through social media outreach
RO2-1: Soil biodiversity data provided by citizen science activities across Europe addressing different soil types and biogeographical regions (16500 entries in the dataset ECHOREPO).	Enhances data collection and diversity of soil health information across Europe.
RO2-2: >20000 downloads of the training tools from the ECHO website.	Promotes the widespread use of educational resources for soil health.
RO2-3: Direct contacts with school and other organisations / associations that want to participate.	Encourages educational institutions and organizations to engage in soil health activities.
RO3-1: 16500 sampled soil sites assessing 8 soil health indicators – large scale soil health assessment including large scale molecular analysis (bacterial and fungal diversity) and heavy metal monitoring.	Provides comprehensive soil health data through extensive sampling and analysis.
RO4-1: Harmonized EU-wide ECHO data support together with EUSO soil perspectives relevant for the EU soil strategy, the Common Agricultural	Integrates soil health data into broader EU strategies and policies.

Indicator	Alignment with Soil Deal for Europe Implementation Plan
Policy (CAP), Zero Pollution Action Plan and Sustainable Development Goals (SDGs).	
RO4-2: >20000 citizen scientists using ECHO technologies.	Engages a large number of citizen scientists in soil health monitoring and data collect
RO4-3: >5000 data accessed through ECHOREPO.	Increases accessibility to soil health data for research and policy-making.
RO4-4: +4 services integrated into the European Open Science Cloud (EOSC).	Enhances data sharing and collaboration and the creation of a soil health cloud
CI1: >15000 website visitors and page views	Increases public awareness and engagement with soil health topics.
CI2: 4 press releases for the duration of the project	Ensures dissemination of project findings and progress to a wider audience.
CI3: > 800 X (ex-Twitter) follower	Expands the project's reach and influence through social media engagement.
CI4: > 300 subscribed to LinkedIn	Engages professional networks and stakeholders in soil health initiatives.
CI5: 2 newsletter/year, totaling 500 views year	Provides regular updates and maintains continuous communication with stakeholders.
CI6: 2 videos (2-3 minutes) and 4 shorter clips (60 seconds), 100000 views for each video	Increases public understanding and visibility of soil health issues through engaging multimedia.
CI7: 10 posts/month	Maintains consistent communication and engagement with the public and stakeholders.
CI8: 8 scientific papers	Contributes to scientific knowledge and validates project methodologies and findings.
CI9: 2 outreach articles/year	Enhances public education and outreach on soil health topics.
CI10: > 40 attendants/event	Ensures active participation and engagement in project-related events and discussions.
WI1-1: State of the art on citizen science initiatives for monitoring soil health. Status: done.	Provides an up-to-date overview of citizen science contributions to soil health monitoring.
WI1-2: Assessment framework for citizen science methods. Status: done.	Establishes a standardized framework for evaluating citizen science methods in soil health.
WI1-3: Citizen-generated soil data quality assessment framework. Status: done.	Ensures the reliability and accuracy of soil health data collected by citizens.
WI2-1: Number of methods evaluated for citizen science and soil health.	Supports the evaluation and improvement of methods used in citizen science for soil health monitoring.
WI2-2: Number of interviews with project leaders to explain the methods in depth.	Provides in-depth insights and understanding of methodologies from project leaders.
WI2-3: Number of video guides created.	Enhances accessibility and understanding of soil health methods through visual aids.
WI2-3: Number of viewers on YouTube.	Increases public awareness and education on soil health through online video content.

Indicator	Alignment with Soil Deal for Europe Implementation Plan
WI3-1: Number of participants on the workshops.	Engages participants directly in hands-on learning and discussion about soil health.
WI3-2: Level of community engagement.	Measures and enhances the involvement of the community in soil health initiatives.
WI5-1: Number of stakeholder engagement sessions.	Facilitates direct interaction and collaboration with stakeholders on soil health issues.
WI5-2: Compliance with FAIR principles.	Ensures that data is Findable, Accessible, Interoperable, and Reusable for all users.
WI5-3: User engagement and satisfaction metrics for all services deployed.	Monitors and improves the user experience and effectiveness of deployed services.
WI5-4: Metrics assessing the usage of the API.	Tracks and evaluates the use and performance of the API for soil health data.
WI5-5: Number of times the ECHO platform is accessed.	Measures the reach and utilization of the soil health information platform.
KABI-1: Soil knowledge.	Enhances the understanding and dissemination of knowledge related to soil health.
KABI-2: Connectedness to soil.	Promotes the connection and engagement of individuals with soil health and its importance.
KABI-3: Sustainable Soil Behaviour.	Encourages sustainable practices and behaviours related to soil management and health.

4.3 Evaluation instruments

In this section, the diverse range of tools and methodologies that will be employed to assess the efficacy and impact of the project are introduced under the established Monitoring and Evaluation Framework. This section is essential for outlining how each instrument will be strategically utilized to gather, analyze, and interpret data across ECHO. These tools are designed not only to measure the project's success against its objectives but also to provide insights that enable continuous improvement and strategic decision-making throughout the project's lifecycle.

4.3.1 Internal reporting

The internal reporting mechanism plays a crucial role as it provides essential information connected to all primary activities within our project's WP. This reporting facilitates:

- Monitoring key output indicators for various activities, such as the number of users on the platform, X (ex-Twitter) followers, and available resources.
- Gathering feedback and insights from the partners participating in the project. This includes both formative feedback on training sessions, workshops, and citizen science campaigns — highlighting what was effective and what was not—as well as feedback on the overall impact of the project and its perceived benefits for participants.

In pursuit of these objectives, we have planned several initiatives:

- Development of a detailed spreadsheet for internal reporting on dissemination and outreach, as prepared by WP1 in collaboration with WP7.
- Routine online meetings conducted by the evaluation team with all WP leaders to review their ongoing activities and outcomes.
- Yearly interviews conducted by members of ECHO. These interviews aim to document any shifts in institutional commitment to citizen science or assess regional and national impacts resulting from involvement in the ECHO project.

4.3.2 Usage statistics and analysis of comments shared on web, platform and app

We will deploy three digital tools to facilitate user engagement across different aspects of our project. These tools are:

Web Page

- Description: The web page serves as the central communication hub for disseminating project outputs and informing the wider ECHO community about upcoming open calls and the status of the project.
- Analytics approach: To measure engagement and gather insights, we will use Google Analytics and similar tools. These will help us track metrics such as new and returning visitor counts, geographic distribution of visitors, most and least visited pages, and overall user engagement on the page.
- Examples of indicators we can use:
    - Number of visitors (distinguishing between new and returning).
    - Visitors' countries of origin.
    - Pages most visited and those less visited.
    - User journeys through the platform, indicating navigation paths.
    - Time spent on the ECHO website.

Web Platform:

- Description: This platform is specifically designed for user interaction with data from citizen science campaigns, allowing users to engage with and analyze the observations made.
- Analytics approach: We will utilize Google Analytics or similar tools on the Web Platform to monitor various user interaction metrics. This will enable us to understand how users interact with the platform's features and resources, helping us to continuously optimize and improve the user experience.
- Examples of indicators we can use:
    - Frequency of user logins to measure engagement.
    - Number and type of interactions with the data (e.g., views, downloads, shares).
    - Completion rates of analyses or reports generated by users.
    - Feedback scores or satisfaction ratings provided by users.
    - Detailed user journey mappings to identify common paths and potential bottlenecks.

Mobile App

- Description: Available on both Android and iOS, this app facilitates direct uploads of observations by citizen scientists. It is designed to be accessible and user-friendly, encouraging active participation from the community.
- Analytics approach: Usage metrics such as the number of downloads, user ratings, and activity levels will be monitored through the app stores for both Android and iOS. These metrics will provide valuable insights into the app's reach, user engagement, and overall reception.
- Example of indicators we can use:
    - Number of downloads of the app.
    - Active user count and session frequency to gauge engagement.
    - Geographic distribution of app users to understand reach.
    - Types of observations uploaded (e.g., photo uploads, text entries)
    - User ratings and reviews in the app stores.

Additionally, both the Web Platform and the Mobile App are supported by a centralized database, interconnected through an API. This integration ensures efficient data management and real-time updates, enhancing our capability to analyze user behaviors and interactions across our digital tools comprehensively. Examples of indicators we can use to analyze API usage are:

- Number of API calls: Tracking the total number of API requests made by the web platform and mobile apps. This helps in understanding the load and demand on the API.
- Response times: Measuring the average time taken for the API to respond to requests. This is critical for assessing the performance and efficiency of the API.
- Error rates: Monitoring the rate of failed API requests. A high error rate could indicate issues with API stability or integration problems with the web platform or mobile apps.
- Data throughput: Quantifying the amount of data being transmitted through the API. This helps in understanding the scalability needs and potential bottlenecks.
- User types and frequency of access: Identifying which components (web platform or mobile app) are making requests and how frequently, to gauge dependency and usage patterns.

4.3.3 Feedback Forms for Workshop and Focus Group Participants

To effectively evaluate the level of satisfaction and identify areas for improvement in our series of 28 co-creation workshops and at least one focus group per consortium country, we have developed a comprehensive feedback collection strategy. This involves the use of a lightweight, user-friendly feedback form, available in both online and offline formats, to accommodate all participants attending these in-person events.

The design of the feedback form is streamlined to encourage participation and ensure ease of use, while also gathering valuable insights. Participants will be asked to provide their opinions on various aspects of the events, such as the quality of content, the effectiveness of the facilitators, the relevance of the topics discussed, and the overall event organization. Additional questions may explore the adequacy of the venue, the timing of the sessions, and the communication leading up to the event.

To ensure the privacy of all participants and promote honest and open feedback, all responses will be collected anonymously. This anonymity is crucial as it encourages more candid and constructive feedback, which is vital for the accurate assessment of the workshops and focus groups.

Furthermore, the dual format of the feedback form (online and offline) not only facilitates accessibility for all participants but also caters to different preferences and levels of technological accessibility. By implementing this feedback mechanism, we aim to capture a comprehensive view of participant experiences, which will be instrumental in refining future workshops and enhancing the overall effectiveness of our consortium activities. This form is shown in Annex 2.

4.3.4 Participant indicators

To collect participant indicators, as well as to gather more information for a deeper analysis of the impact of ECHO initiatives on participants' intellectual and motivational abilities in relation to soil, personal data will be gathered through a series of questions presented during the registration phase when participants first enter the ECHO citizen science mobile app (currently in development). These questions will collect socio-demographic information of individuals involved in the project initiatives. Examples include:

- Age
- Gender
- Country of residence
- Place of residence (City vs. Country)
- Educational background
- Profession
- Previous engagement in citizen science initiatives
- Number of soil samples taken
- Participation in ECHO events, workshops and/or trainings, if scheduled

The collected data will be stored and transferred securely in formats such as .csv or .xlsx for subsequent statistical analysis. To ensure full compliance with the GDPR, all personal data will be processed with the highest level of security and confidentiality. We will implement appropriate technical and organizational measures to safeguard personal data, ensuring that data collection is lawful, fair, and transparent. Participants will be informed of their rights under GDPR, including the right to access, correct, and request the deletion of their data. See section 7 and D7.3 for further details.

4.3.5 Participants' surveys

To evaluate participants' soil knowledge, connectedness to soil, and sustainable soil behaviour, three surveys have been developed. The development of questions was guided by literature review and, for two of the surveys, it was also guided by expert interviews with soil science specialists. The final questions (also often referred to as items) were either self-constructed from this information or were original or modified from other scales measuring similar constructs. The surveys were then pre-tested with a panel of German participants recruited through Cint (https://de.cint.com/), with a total of N = 581 for the connectedness to soil and sustainable soil behaviour scale and N = 160 individuals for the soil knowledge scale. Participants answered the three surveys online using the SoSciSurvey platform (https://soscisurvey.de).

The results of the pre-test allowed us to evaluate the psychometric properties of the surveys, including their validity and reliability. This evaluation was primarily guided by Item Response Theory and other analyses, such as reliability and correlation analyses. The statistical analyses were conducted using R

(version 4.3.1) software (R Core Team, 2023). According to the results of this evaluation, and after incorporating feedback from the ECHO partners, several adjustments were made to refine the original surveys, resulting in their finalized versions (see Annex 1):

- **Soil Knowledge Scale:** This scale consists of 20 items (e.g., "Which of the following processes is a soil-forming process?"). The items are either single choice questions or contain a true or false response format. The items have been developed through interviews with soil experts from Germany and Italy and verified with other experts from within the ECHO project. A 3-PL item response model was fitted to the pre-test of a German sample and yielded an acceptable fit (e.g., RMSEA = .06). The empirical reliability was r = .70.
- **Connectedness to Soil Scale:** This scale assesses connectedness to soil through 22 cognitive, affective and behavioural items (e.g., "I recognize and appreciate the intelligence of organisms living in the soil" or "I feel that the soil and humans share a common "life force"""). These items are answered on a 5-point Likert scale ranging from 1= Strongly disagree to 5= Strongly agree. This scale demonstrated high reliability, with a Cronbach's alpha coefficient of $\alpha = 0.94$, and acceptable validity. When fitted to a Rasch model, the scale demonstrated an acceptable fit (e.g., RMSEA= .08).
- **Soil Conservation Motivation Scale:** This scale assesses sustainable soil behaviour through 21 behavioural items. These items cover a broad range of soil conservation behaviours such as "I apply mulch in my garden" or "I watch documentaries about soil". The response format is adopted to the item formulation and responses are either given as yes/no statements or on a 5-point Likert scale ranging from 1 = never to 5 = very often. The psychometric scale showed high reliability (item separation reliability = 0.985), and good validity. When fitted to a Rasch model, it showed good fit indices, with infit mean square indices ranging from 0. 733 and 1.211.

The final versions of the three surveys were translated into all the languages of the ECHO partners, with each partner tasked to translate the versions into their respective language (at a later stage, the surveys will also be translated into the remaining official European languages). The surveys, in all official European languages, will be integrated into the ECHO citizen science Mobile App (still in development). These surveys will serve as pre-measures, administered through the app before participants take their first soil sample, marking the initial assessment (T1) of their intellectual and motivational abilities related to soil. Subsequently, a second measurement point (T2) will occur towards the end of their participation in the citizen science initiatives, where the surveys will be reapplied through the app after participants take their soil sample(s), potentially following participation in workshops or trainings if scheduled. These pre- and post-measures aim to evaluate the impacts or changes resulting from ECHO initiatives. Finally, a third measurement point (T3) will occur a few months after the project's conclusion, wherein the surveys will be administered for the third time, to evaluate the long-term impacts of the ECHO initiatives.

The collected data from the three measurement points will be transferred to either a .csv, .xlsx or a similar format for subsequent statistical analysis.

5 Project self-assessment & reflection

Throughout the project, a structured self-assessment will be conducted during two strategically planned online consortium meetings. This assessment is built upon a set of carefully curated questions that follow the evaluation framework developed by Kieslinger et al. (2017), which was originally

tailored for assessing citizen science projects. Given the distinct nature of our project, we will customize this framework to reflect our specific goals more accurately, thus enabling a more effective evaluation.

Our self-assessment process is divided into two primary categories:

1. **Process & feasibility:** This category assesses the practical aspects of our project's delivery. For each dimension—scientific, participant, socio-ecological and economic, and knowledge, attitude, and behavior—we will examine the methodologies, engagement strategies, sustainability alignment, and knowledge dissemination efforts. This will help us understand how feasibly and effectively these processes are being implemented within the project framework.
2. **Outcome & Impact:** This category focuses on the results and changes brought about by the project. It evaluates the scientific contributions, participant development, socio-economic impacts, and shifts in stakeholder attitudes and behaviors. This category is crucial for determining the tangible and intangible project outcomes.

The primary objective of these self-assessments is to facilitate a meaningful dialogue among consortium members, fostering a collaborative environment where insights and perspectives on the project's success are shared. Through this dialogue, we aim to reach a consensus on various aspects of the project, based on a pre-defined set of questions. These questions address key project dimensions at four levels: scientific quality, participant engagement, socio-economic impact, and shifts in knowledge, attitudes, and behaviors.

The structured assessment will occur prior to the first review meeting and again at the project's conclusion. This timing ensures that we can use the insights gained to inform ongoing project activities and final evaluations. Furthermore, this reflective practice will enable us to identify and leverage our strengths while addressing any challenges that arise, enhancing the project's overall impact.

Results and insights from these assessments will be meticulously documented and versioned, providing a clear record of progress and areas for improvement. This documentation will also support our discussions on internal evaluation outcomes, helping us to better understand and articulate the project's impact across its varied dimensions.

6 Time Plan

6.1 Internal reporting

Ibercivis Foundation will communicate with each WP leader on a bi-monthly basis. Before these communications, WP leaders will be required to fill out a spreadsheet, which will provide up-to-date information on the indicators for which they are responsible. This systematic approach ensures that we have current data on all relevant indicators, facilitating a comprehensive overview of project progress. Regular reporting is crucial for several reasons:

- **Timely identification of issues:** By maintaining a monthly reporting schedule, any potential problems or delays can be identified early. This proactive approach allows us to address issues before they escalate, ensuring that the project remains on track.
- **Data accuracy:** Continuous data collection and reporting enhances the accuracy of our monitoring efforts. Regular updates help avoid data gaps and ensure that all project activities are accounted for.

- **Informed decision-making:** With up-to-date information on hand, project managers and WP leaders can make informed decisions. This data-driven approach enhances the overall management of the project and ensures that resources are allocated effectively.
- **Implementation of corrective measures:** Having current information allows us to implement corrective measures swiftly. If an indicator shows that a particular aspect of the project is not meeting its targets, we can adjust our strategies and actions accordingly.

6.2 Usage statistics and analysis of comments shared on web, platform and app

For effective monitoring of usage statistics and the analysis of comments shared on our **website,** web platform and app, we will leverage existing tools to collect these data. WP5 is responsible for gathering this information, ensuring that we have continuous access to the latest insights regarding user interactions and feedback.

To ensure the effective utilization of these data, we will conduct bi-monthly analysis meetings. During these meetings, the data collected by WP5 will be thoroughly reviewed to assess the progress and performance of our digital platforms. These meetings serve several key purposes:

- **Reviewing progress:** By regularly analyzing usage statistics and user comments, we can gauge user engagement with our web platform and app.
- **Identifying trends and issues:** Regular analysis allows us to identify any emerging trends or recurring issues in user feedback.
- **Establishing corrective measures:** Based on the insights gained from the bi-monthly analysis, we will establish corrective measures as needed.
- **Enhancing user engagement:** By continuously monitoring and responding to user feedback, we can implement changes that enhance user engagement and satisfaction, ensuring that our platforms are effectively supporting the goals of the ECHO project.

6.3 Feedback Forms for Workshop and Focus Group Participants

After each workshop, focus group session, or participatory activity, the survey provided in Annex 2 will be administered to all participants. This survey is designed to evaluate the effectiveness of the workshop or session and gather valuable feedback from participants.

6.4 Participant indicators & Participants' surveys

Table 11 shows the planned schedule for administering the participant surveys:

Table 10: *Participants' surveys time plan*

Participants' surveys			
Surveys to be administered	Measurement points		
	T1: Before soil sampling	T2: After soil sampling	T3: After the conclusion of the project
Socio-demographic data	✓		
Soil Knowledge Scale	✓	✓	✓
Connectedness to Soil Scale	✓	✓	✓
Soil Conservation Motivation Scale	✓	✓	✓

7 Ethics

In the delivery of our project, we are committed to upholding the highest ethical standards. As part of this commitment, we will be collecting personal data from participants through various methods, including interviews, focus groups, discussions, and during registration on the ECHO citizen science mobile app.

To ensure compliance with ethical guidelines and protect participant privacy we have the following instruments:

Informed consent: We have developed comprehensive informed consent protocols, which will be clearly communicated and distributed to participants involved in any evaluative activities. These protocols inform participants about the nature of the data collection, the purpose of their data usage, and their rights regarding data privacy. Each participant must agree to these terms before engaging in any part of the project.

Data Privacy Statement: Specifically for participants registering through the ECHO citizen science mobile app, we will provide a detailed Data Privacy Statement. This statement, which must be agreed upon before participants submit any personal information, outlines how their data will be used, stored, and protected.

Ethical Approval: All data collection methods and instruments, including the specifics of data to be collected, have been rigorously reviewed and approved by the UNIBZ ethical committee. This ensures that our methods meet all regulatory requirements and ethical standards set by that committee.

Further details on our ethical approach, including the measures we take to ensure the confidentiality and security of personal data, can be found in D7.3 Ethics requirements, submitted in M8.

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Annex 1 Participants' Surveys

Soil Knowledge Scale (SKS-20)

Table 11: *Soil Knowledge Scale Survey*

No.	Item	Format	Response
1-2	Which of the following processes is a soil-forming process?	True/False	a. decomposition b. erosion
3-5	The following factors are crucial in soil formation:	True/False	a. temperature differences b. water c. composition of air
6	Humus is a nutrient-rich organic substance derived from dead plant and animal material.	True/False	
7	Humus is primarily found in…	Single Choice	a. … the lower layer of the soil b. … the middle layer of the soil. c. … the upper layer of the soil.
8	Soils play a crucial role in climate change.	True/False	
9	Which statement is correct regarding the processing of carbon dioxide?	Single Choice	a. Only plants process carbon dioxide b. Soils also play a role in carbon dioxide storage and processing.
10	Soil, along with water and air, is the most crucial resource on Earth because…	True/False	… they produce food
11	Which statement about soil functions is incorrect?	Single Choice	a. Soils serve as a storage for water. b. Soils play no role in filtering water. c. The buffering function of the soil regulates the water balance. d. Soils support the filtration of water through various layers.
12	Soil health and human health are not related	True/False	
13	What does erosion mean?	Single Choice	a. The contamination of soils by heavy metals

No.	Item	Format	Response
			b. The salt accumulation in soils due to irrigation agriculture. c. The removal of fertile topsoil by wind or water.
14	Monocultures lead to…	Single Choice	a. high diversity of soil organisms, a low risk of erosion, and the enrichment of various nutrients. b. a low diversity of soil organisms, a high risk of erosion, and nutrient depletion. / b. a low diversity of soil organisms and nutrient depletion.
15	Soil-degrading factors limit the ecosystem services of the soil.	True/False	
16	Which agricultural practice has a positive impact on soil health?	Single Choice	a. The application of fertilizers. b. Integration of cover cropping. / b. increasing the diversity of tree species. c. Maintaining monocultures.
17	How does greening soil areas contribute to soil conservation and biodiversity?	Single Choice	a. It improves soil structure, prevents erosion, and promotes biodiversity. b. It promotes erosion and soil loss but has positive effects on biodiversity. c. It degrades the water-holding capacity of the soil but has positive effects on biodiversity.

No.	Item	Format	Response
18-19	How can one best test the health of soils?	True/False	a. Assessing soil biodiversity. b. By observing above-ground plant growth.
20	Which step is an essential part of soil improvement?	Single choice	a. The addition of organic materials through composting. b. The use of pesticides. c. The use of chemical fertilizers

Connectedness to Soil Scale (CtS-22)

Table 12: *Connectedness to Soil Scale Survey*

No.	Item	Response
1	It upsets me greatly to see the soil being harmed or destroyed.	1=Strongly Disagree 2=Disagree 3=Neutral 4=Agree 5=Strongly Agree
2	I feel that the soil and humans share a common "life force".	1=Strongly Disagree 2=Disagree 3=Neutral 4=Agree 5=Strongly Agree
3	I think of the soil as my family.	1=Strongly Disagree 2=Disagree 3=Neutral 4=Agree 5=Strongly Agree
4	I feel as though I belong to the soil as equally as it belongs to me.	1=Strongly Disagree 2=Disagree 3=Neutral 4=Agree 5=Strongly Agree
5	I have a strong bond with the soil and its ecosystems.	1=Strongly Disagree 2=Disagree 3=Neutral 4=Agree 5=Strongly Agree

No.	Item	Response
6	I feel a sense of reverence for the soil and its natural processes.	1=Strongly Disagree 2=Disagree 3=Neutral 4=Agree 5=Strongly Agree
7	I feel spiritually connected to the soil and the life it sustains.	1=Strongly Disagree 2=Disagree 3=Neutral 4=Agree 5=Strongly Agree
8	I feel a duty to protect and nurture the soil for future generations.	1=Strongly Disagree 2=Disagree 3=Neutral 4=Agree 5=Strongly Agree
9	I feel that the land is a part of who I am.	1=Strongly Disagree 2=Disagree 3=Neutral 4=Agree 5=Strongly Agree
10	I observe how soil organisms interact.	1=Strongly Disagree 2=Disagree 3=Neutral 4=Agree 5=Strongly Agree
11	I put my hands in the soil.	1=Strongly Disagree 2=Disagree 3=Neutral 4=Agree 5=Strongly Agree
12	I engage in activities like gardening or farming to interact with the soil.	1=Strongly Disagree 2=Disagree 3=Neutral 4=Agree 5=Strongly Agree
13	I often partake in rituals or practices to give thanks to the soil and to wish for a bountiful harvest or season.	1=Strongly Disagree 2=Disagree 3=Neutral 4=Agree 5=Strongly Agree

No.	Item	Response
14	I recognize and appreciate the intelligence of organisms living in the soil.	1=Strongly Disagree 2=Disagree 3=Neutral 4=Agree 5=Strongly Agree
15	Soil is a living entity with its own intrinsic value.	1=Strongly Disagree 2=Disagree 3=Neutral 4=Agree 5=Strongly Agree
16	I see the land as a living entity with which humans can communicate and interact.	1=Strongly Disagree 2=Disagree 3=Neutral 4=Agree 5=Strongly Agree
17	I consider the soil to be an essential part of my life and well-being.	1=Strongly Disagree 2=Disagree 3=Neutral 4=Agree 5=Strongly Agree
18	I consider the soil to be a teacher, showing us the importance of patience and resilience.	1=Strongly Disagree 2=Disagree 3=Neutral 4=Agree 5=Strongly Agree
19	I believe that the health of the soil is interconnected with the health of all living organisms.	1=Strongly Disagree 2=Disagree 3=Neutral 4=Agree 5=Strongly Agree
20	The health of the soil is intimately tied to my own well-being.	1=Strongly Disagree 2=Disagree 3=Neutral 4=Agree 5=Strongly Agree
21	I have a deep understanding of how my actions affect the soil.	1=Strongly Disagree 2=Disagree 3=Neutral 4=Agree 5=Strongly Agree

No.	Item	Response
22	I often think of myself as a custodian of the soil.	1=Strongly Disagree 2=Disagree 3=Neutral 4=Agree 5=Strongly Agree

Soil Conservation Motivation Scale (SCB-21)

Table 13: *Soil Conservation Motivation Scale survey*

No.	Item	Response
1	I use apps to determine the health of the soil.	Yes/No
2	I help with soil mapping via apps.	Yes/No
3	I buy peat-free soil.	Yes/No
4	I have organized an event on soil protection.	Yes/No
5	I have specialist books about soil.	Yes/No
6	I compost kitchen waste such as vegetable and fruit peelings.	1 = never 2 = rarely 3 = occasionally 4 = often 5 = very often
7	I reuse dead leaves in my garden.	1 = never 2 = rarely 3 = occasionally 4 = often 5 = very often
8	I use organic fertilizer.	1 = never 2 = rarely 3 = occasionally 4 = often 5 = very often
9	If I see an earthworm on the road, I take it to a safe place.	1 = never 2 = rarely 3 = occasionally 4 = often 5 = very often
10	I encourage other people to compost their organic waste.	1 = never 2 = rarely 3 = occasionally 4 = often 5 = very often
11	I donate money to projects that promote soil conservation.	1 = never 2 = rarely 3 = occasionally 4 = often 5 = very often
12	I grow robust species that suit the environmental conditions in my region.	1 = never 2 = rarely 3 = occasionally 4 = often 5 = very often
13	I buy regional products.	1 = never 2 = rarely 3 = occasionally

No.	Item	Response
		4 = often 5 = very often
14	I buy seasonal food.	1 = never 2 = rarely 3 = occasionally 4 = often 5 = very often
15	If I see garbage lying on the ground, I pick it up.	1 = never 2 = rarely 3 = occasionally 4 = often 5 = very often
16	If I see a cigarette butt lying on the ground, I pick it up.	1 = never 2 = rarely 3 = occasionally 4 = often 5 = very often
17	I actively inform myself about soil.	1 = never 2 = rarely 3 = occasionally 4 = often 5 = very often
18	I take part in clean-up campaigns.	1 = never 2 = rarely 3 = occasionally 4 = often 5 = very often
19	I tell other people about the importance of soil for the health of our ecosystem.	1 = never 2 = rarely 3 = occasionally 4 = often 5 = very often
20	I watch documentaries about soil.	1 = never 2 = rarely 3 = occasionally 4 = often 5 = very often
21	I reprimand people when I see them throwing garbage on the ground.	1 = never 2 = rarely 3 = occasionally 4 = often 5 = very often

Annex 2 Feedback forms

Workshop/Focus Group Feedback Form

Thank you for participating in our event. Your feedback is essential for us to improve future workshops and focus groups. Please fill out this anonymous form to help us understand your experience better.

1 Event Details

Event Name:

[Text field]

Event Date:

[Text field]

Location:

[Text field]

2 Your experience

Overall, how satisfied were you with the event? (1 being not satisfied at all, 5 being very satisfied)

[ ] 1 [ ] 2 [ ] 3 [ ] 4 [ ] 5

What was the most valuable aspect of the event for you?

[Text field]

How relevant was the content presented at the event?

[ ] Not relevant [ ] Somewhat relevant [ ]Neutral [ ] Relevant [ ] Highly relevant

How effective was the facilitator in presenting the material?

[ ] Not effective [ ] Somewhat effective [ ] Neutral [ ] Effective [ ] Highly effective

Was the event organized efficiently?

[ ] Strongly disagree [ ] Disagree [ ] Neutral [ ] Agree [ ] Strongly agree

If relevant, how adequate was the venue for the event?

[ ] Inadequate [ ] Barely adequate [ ] Adequate [ ] Very adequate [ ] Extremely adequate

Was the duration of the event appropriate?

[ ] Far too short [ ] Somewhat short [ ] Just right [ ] Somewhat long [ ] Far too long

3 Additional feedback

What did you like least about the event?

[Text Field]

What could be improved for future events?

[Text Field]

Any other comments or suggestions?

[Text Field]