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A review of existing tools for citizen science research on soil health

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Contents

Abstract

Soil-related citizen science projects have gained significant interest driven by the prominence of soil within public policy agendas. Amongst others, this includes the EU Soil Strategy for 2030, which contributes to the objectives of the EU Green Deal and proposes specific actions to increase citizen engagement on soils. Increasing citizen engagement is also one of the building blocks in the EU Mission: A Soil Deal for Europe.

In this work, we reviewed over 60 citizen science projects, across the globe, that considered soil health. We collected citizen science projects based on literature search, expert interviews, suggestions from project partners and through the mailing lists of the European Network for Soil Awareness (ENSA) and the European Soil Data Centre (ESDAC). We then screened all projects for the following characteristics: geographic coverage, duration, scientific factors (e.g. soil properties considered, fieldwork), technological factors (e.g. applications used) and their citizen engagement (e.g. target groups).

Two-thirds of the reviewed studies were based in Europe and mostly conducted at regional- or national scales. We recommend to align the citizen science methodology with the desired level of participation. We also identified a need for the development of standardised, user-friendly and cost-effective methodologies to generate soil data. Engagement of citizen can be facilitated through, i.) providing feedback protocols on their scientific contribution and, ii.) assigning qualified mediators or activity leaders to support participants throughout the project. All collected information has been made available as an open-access repository and can inform future citizen-science projects on soil health.

Acknowledgements

AP led and conducted the review, analysis and writing of the ECHO report; FS and TM contributed to the analysis and writing of the ECHO report; TB synthesized text and figures from the ECHO report into this technical report. AP, TM, PP and AJ reviewed this technical report.

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Disclaimer

This report was first written in context of the Mission Soil funded ECHO project, for the deliverable named “Report on the state of the art of citizen science applied to soil” (Peiro, A., Sanz, F., Mimmo, T. and Pulido, M., under review: Report on the state of the art of citizen science applied to soil, Deliverable 1.1 for the ECHO project, 37 p) and synthesized and modified for the deliverable "Review of existing tools for citizen science" (Administrative arrangement JRC and DG AGRI/RTD).

In this synthesis of the ECHO project deliverable D1.1 (Peiro, A., Sanz, F., Mimmo, T. and Pulido, M., under review: Report on the state of the art of citizen science applied to soil, Deliverable 1.1 for the ECHO project, 37 p) the authors have used the first-person pronoun for the statements. However, all these statements were firstly made in the original deliverable of the ECHO project. Moreover, not all the original authors included in the ECHO project deliverable have read this synthesis.

Introduction

Soil is a vital 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, which stands for 'Engaging citizens in soil science: the road to healthier soils', 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. The project will develop and deploy 28 tailor-made citizen science initiatives across EU Member States and Scotland, considering different land-uses, soil types, and biogeographical regions, as well as stakeholder needs. The repository created by ECHO will provide information about the state of soil health in various regions, and help citizens make informed decisions about land use and conservation.

This report provides an overview of the current state of the art of citizen science initiatives and projects on soil health. The aim of the original deliverable was to provide recommendations for the methodology of the ECHO project. It examines the evolution and impact of soil-related citizen science projects, highlighting their role in environmental stewardship and policy development.

The remainder of this introduction provides a historical context of soil-focused citizen science projects and reviews. The second chapter outlines the methodology to select and classify citizen science projects to be included in the review. In the third chapter, the projects that were reviewed are presented and summarized by their objectives, scientific, technological and engagement factors. Lastly, the results are discussed such that knowledge gaps and recommendations for future research are identified. Additionally, a selection of non-soil health related citizen science projects are discussed for their relevant insights. Finally, the conclusions consist of a set of recommendation for the ECHO project.

Recently, soil-related citizen science projects have gained significant interest driven by the prominence of soil within public policy agendas (Panagos, 2022; Gascuel et al., 2023a), mainly in:

- The EU Soil Strategy for 2030 (European Commission, 2021a), which contributes to the objectives of the EU Green Deal, and it is part of the Biodiversity Strategy. This Strategy proposes specific actions in relation to citizen engagement, including citizen science.
- The EU Soil Observatory (EUSO; European Commission, 2020), which supports the implementation of the EU Soil Strategy 2030 and other relevant EU policies.
- The Common Agricultural Policy 2023-27 (CAP; European Commission, 2021b), which is a key EU land management policy and a central driver for the management of agricultural land.
- The EU Action Plan "Towards a Zero Pollution for Air, Water and Soil" (European Commission, 2021c), which contains several measures specifically targeting soils.
- The Mission 'A Soil Deal for Europe' (Mission Soil) of the Horizon Europe, which is one of the five Research and Innovation Missions to bring solutions to major societal challenges, therewith meeting global commitments such as the Sustainable Development Goals.

This review was conducted in context of ECHO[1], a Mission Soil funded project. The ECHO 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.

In recent years, several reviews had their focus on citizen science in relation to the natural environment, but did not summarize all projects related to soil (e.g., Peter et al., 2019; Adamou et al., 2021; Hadjichambi et al., 2023). Each recent reviews on soil citizen science projects assessed a subset relevant to their research objective. Mainly, Head et al. (2020) reviewed existing citizen science methods and platforms for soil health monitoring. They considered the cost, reliability, and accessibility of the existing methods and toolkits of a total of 33 citizen science soil monitoring initiatives. Ebitu et al. (2021) conducted an in-depth review of four citizen science projects related to sustainable agriculture and soil health. Pino et al. (2022) reviewed 50 soil citizen science initiatives around the world. Their aim was to assess how initiatives raised the participants' awareness by collecting information on the project's motivation, technologies employed and the participants' profiles. Wadoux & McBratney (2023) assessed soil citizen science initiatives on their degree of participation and found that contributory projects were most common and long-term outcomes were rarely reported. Gascuel et al. (2023a, b) focused on identifying soil citizen science projects in France, gathering a total of 20 such initiatives. They concluded that the initiatives were mostly concerned with raising awareness, take soil into account in public policies, as well as to develop practical tools for evaluating soil biodiversity. Gascuel et al. (2023b) continued their inventory post-publication therewith reviewed the use of citizen science on soils and agroecosystems across Europe. Many initiatives generated soil biodiversity, vegetation cover and soil organic carbon data, and have reported the educational value and satisfaction (derived from meaningful scientific participation) as benefits for the citizen scientists. However, they do not provide an overviews of the projects in their inventory.

Whereas each of these reviews has its own research value, they did not summarize the current state of soil citizen science, meaning a systematic overview of past projects. Therefore, this review was undertaken to synthesize previous soil citizen science projects. Our principal research objective was to create a systematic overview of previous soil citizen science projects, establishing a repository of potentially useful resources from past citizen science initiatives that study soil health. This objective allows for identifying knowledge gaps in past citizen science alternatives in terms the soil properties measured, geographic coverage, and citizen science methods employed. This study thus considers a wide range of citizen science initiatives, identifying emergent patterns, establishing best practices, and pointing out opportunities for the advancement of citizen science contribution to research, environmental stewardship and policy.

[1] https://echosoil.eu/

1 Methodology

This study's methodology consisted of four main components. Firstly, the construction of a matrix that details the criteria to be assess for each soil citizen science project. Second, the matrix was then elaborated based on the results from available reports or documents on projects, initiatives or activities from both inside and outside the European Union (EU). Third, we carried out some direct interviews with key representatives or stakeholders of projects for which further details were required. Fourth, project partners of the ECHO Horizon project (under which this research was funded) as well as external partners verified initiatives and provided details on projects already under our consideration, filling gaps and adding new perspectives.

1.1 Constructing a matrix of criteria to assess citizen science initiatives

Although different definitions exist and are under debate in the scientific community, we adopted the definition of 'non-professional involvement of volunteers in the scientific process, commonly in data collection, but also in other phases, such as quality assurance, data analysis and interpretation, problem definition and dissemination of results' (De Rijk et al. 2020). A detailed matrix has been constructed to assess citizen science projects related to monitoring soil health. This matrix is presented as a table, created in a spreadsheet, available at ESDAC[2] and the Ibercivis Foundation (2023). The table was divided into four main sections (refer to Appendix 1 for further details), encompassing the following areas:

— General: this includes basic coordination information and contact details.

— Scientific: covers aspects of the citizen toolkit, scientific details, fieldwork process and sample analysis.

— Technological: mainly concerns the applications that were used in the project.

— Citizen Engagement and Impact: details the type of citizen science and methods implemented, as well as the impact and the extent of the results achieved.

Each section was further subdivided to ensure a comprehensive information collection. All factors considered were revised and endorsed by the ECHO partners involved in the task, prior to compiling the table with pertinent details from projects.

1.2 Literature review

The literature review was an essential task for gathering the available reports or documents to identify the corresponding projects, initiatives or activities from both inside and outside the European Union (EU). This process led to completing the final matrix.

Our selection criteria for projects were that they must have:

— A focus on soil health, encompassing both soil biodiversity and pollution.

— Carried out active engagement of citizens through citizen science approaches.

[2] https://esdac.jrc.ec.europa.eu/content/soil-health-related-citizen-science-projects

- Given the focus on data collection in the ECHO project, we considered the involvement of citizens in data collection as a requirement in order to include a project in the review.

To source pertinent data within the EU, we initiated our search with the European Commission's public repository, the Community Research and Development Information Service (CORDIS, 2023). A targeted search using the terms 'soil' AND 'citizen' yielded 205 results. Each of these entries was scrutinised based on their title, objectives, and results to determine their relevance. This repository provided us both the title and general information, and access to download the content. Additionally, it provided access to the corresponding project websites and platforms, providing additional information and further documentation. The 28 projects funded under Mission Soil have also been consulted at European Commission (2023).

Other national, European and international repositories have been consulted following the same process. Those are:

- EU-Citizen.Science (2023): the search of the term 'soil' yielded 3 results.
- Observatorio de la Ciencia Ciudadana en España (2023): the search of the term 'suelo' yielded 1 result.
- SciStarter (2023): the search of the term 'soil' yielded 32 results*.
- iNAturalist (2023): the search of the term 'soil' yielded 1006 results*.

* Searches in these repositories were very limited because they include the term 'soil' into general environment-related terms. For instance, iNaturalist only focus on monitoring biodiversity of specific species (birds, amphibians, reptiles, mammals, fish, mollusks, arachnids, insects, plants, fungi and protozoans), and most of them are not directly related to soils. Nevertheless, some of the projects established a relationship between those species and soils and were of interest to ECHO.

After conducting this thorough review, Google and Google Scholar were used to verify the information and ensure comprehensiveness in sourcing projects. These search engines facilitated the identification of relevant, current information, assisted in citation tracking, and aided in uncovering related initiatives. Google Scholar offered academic content, encompassing research articles, whereas Google supplied a broad spectrum of sources, from websites to reports.

Lastly, we juxtaposed our list with those presented in prior reviews (Head et al., 2020; Ebitu et al., 2021; Pino et al., 2022; See section 2 of this deliverable for further information). While some overlap occurred, this provided valuable additions. However, we did not include every project from these previous reviews, due to differences in scope. For example, Head et al. (2020) provided a review that also includes methods, or Pino et al. (2022) included documentaries and educational experiments, among others, that do not fully align with our concept of citizen science activities.

1.3 Interviews with key representatives

In the process of reviewing projects, we seldom encountered some limitations in accessing comprehensive information. In some cases, the absence of a project website, linguistic barriers, or limited online documentation, hindered a thorough understanding of the project's objectives, methodologies or impact.

To bridge these gaps and ensure an accurate representation in our review, we carried out some direct interviews with key representatives or stakeholders associated with those projects (e.g. Latrobe Valley Dust Research, Tea Bag Index, Bridges). These interviews were conducted via email, facilitating a structured and detailed exchange of information. Engaging in these dialogues ensured that no initiative was misrepresented due to the absence of digital documentation.

1.4 Partner contributions

1.4.1 Project partners

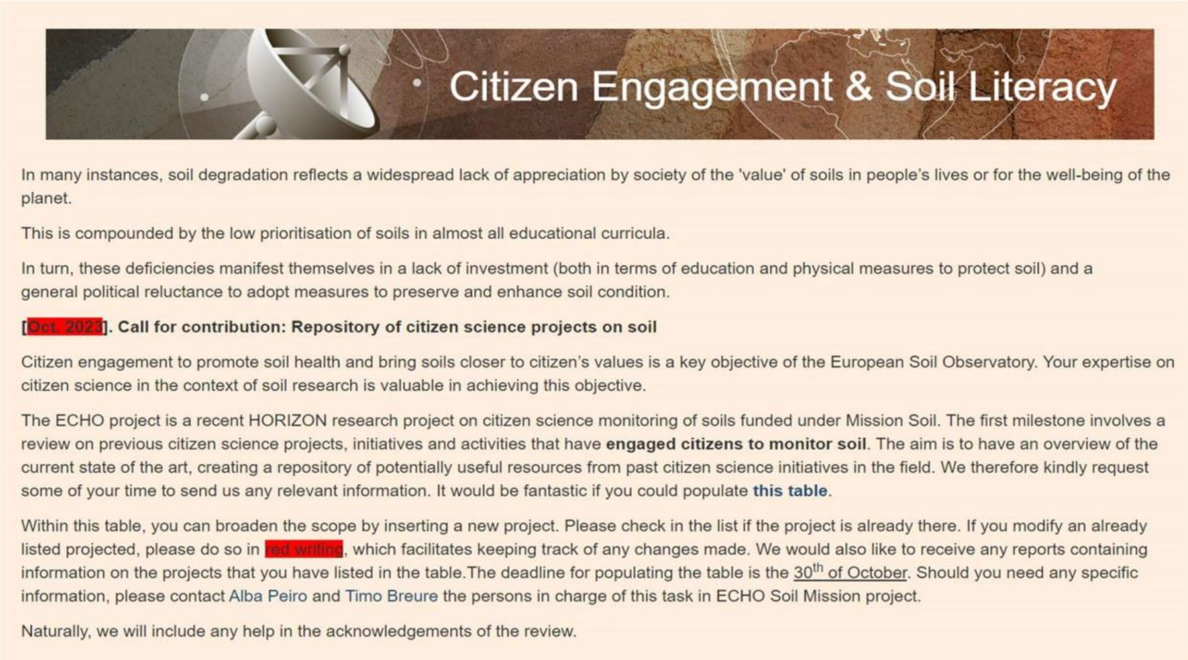
We requested each ECHO partner to compile and consolidate information from projects identified during desk research, led by Ibercivis (Spain). Additionally, they were asked to incorporate any projects that, to their knowledge, engaged citizens in monitoring soil health, which might have been overlooked during the review process.

This collaborative approach was established through three online meetings and mailing threads with all partners. One significant advantage of this method was the ECHO partners' ability to contribute to projects they were familiar with, had expertise in, or those initiatives presented in their native languages. It enabled us to include local projects that ECHO partners could have led or participated in. The ECHO partners were able to identify relevant initiatives that had not been mentioned or referred to online or in the academic literature, perhaps due to their recent inception or their limited geographic scope.

1.4.2 External partners

Collaborative efforts from external entities have further enriched our review. External partners were not directly part of our ECHO consortium but were also recognized as contributors to the database. Mainly, the Joint Research Centre (JRC) has distributed the matrix with criteria through the mailing lists of the European Network of Soil Awareness (ENSA) and the European Soil Data Centre (ESDAC; Fig. 1). All together this has allowed its distribution amongst more than 13,000 recipients.

Figure 1. Call for collaborative contribution to the ECHO T1.1 matrix published in October 2023 by the JRC and ESDAC.



Citizen Engagement & Soil Literacy

In many instances, soil degradation reflects a widespread lack of appreciation by society of the 'value' of soils in people's lives or for the well-being of the planet.

This is compounded by the low prioritisation of soils in almost all educational curricula.

In turn, these deficiencies manifest themselves in a lack of investment (both in terms of education and physical measures to protect soil) and a general political reluctance to adopt measures to preserve and enhance soil condition.

[Oct. 2023]. Call for contribution: Repository of citizen science projects on soil

Citizen engagement to promote soil health and bring soils closer to citizen's values is a key objective of the European Soil Observatory. Your expertise on citizen science in the context of soil research is valuable in achieving this objective.

The ECHO project is a recent HORIZON research project on citizen science monitoring of soils funded under Mission Soil. The first milestone involves a review on previous citizen science projects, initiatives and activities that have **engaged citizens to monitor soil**. The aim is to have an overview of the current state of the art, creating a repository of potentially useful resources from past citizen science initiatives in the field. We therefore kindly request some of your time to send us any relevant information. It would be fantastic if you could populate **this table**.

Within this table, you can broaden the scope by inserting a new project. Please check in the list if the project is already there. If you modify an already listed projected, please do so in red writing, which facilitates keeping track of any changes made. We would also like to receive any reports containing information on the projects that you have listed in the table.The deadline for populating the table is the 30th of October. Should you need any specific information, please contact Alba Peiro and Timo Breure the persons in charge of this task in ECHO Soil Mission project.

Naturally, we will include any help in the acknowledgements of the review.

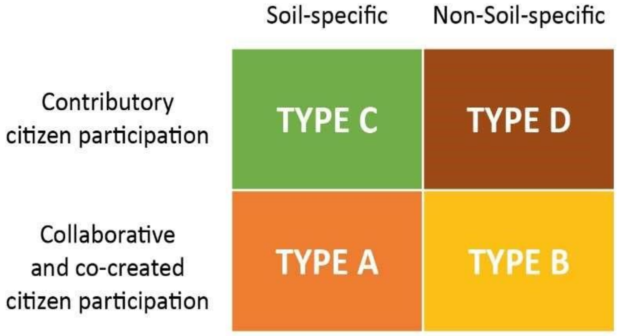
Source: https://esdac.jrc.ec.europa.eu/

Part of these recipients have suggested overlooked initiatives and provided details on projects already under our consideration, they have filled gaps and offered other perspectives. This kind of cross-institutional cooperation underscores the strength of collective expertise and emphasises the importance of networking and information sharing in advancing European citizen science efforts related to soil health.

1.5 Classification of the citizen science projects

Once we came to the final set of projects to review, we used the degree of citizen engagement as a primary distinguishing factor. We distinguished two types: i.) citizens participated in soil sample collection and/or basic interpretations (collaborative), ii.) citizens were broadly engaged in the project (co-creation) (Shirk et al. 2012). Collaborative projects are generally designed by scientists and citizens primarily contribute and, occasionally, analyse data and/or disseminate findings. Co-created projects are designed by both scientists and citizens, at least some of the public participants are actively involved in most or all aspects of the research process (Shirk et al., 2012). The second distinguishing factor used in our classification is whether the main objective of the project was soil-centric or non-soil-centric, leading to a total of four categories (Fig. 2). Lastly, we created a category, labelled 'O', that included other projects of specific interest to inform the methodology of the ECHO Horizon research project.

Figure 2. Quadrat that shows the four categories considered to classify reviewed projects, based on i.) public participation in scientific projects (Shirk et al. 2012), ii.) whether the main objective of the project was soil-centric or not.



Source: Adapted from ECHO deliverable 1.1 (Peiro et al. 2023).

The last step in our methodology was to reclassify the criteria included in the matrix into broader categories. For example, a broad range of soil indicators was studied across the different projects reviewed. To facilitate comparison and the identification of broader trends and patterns we reclassified this depending on whether biological, chemical or physical indicators were studied.

2 Results

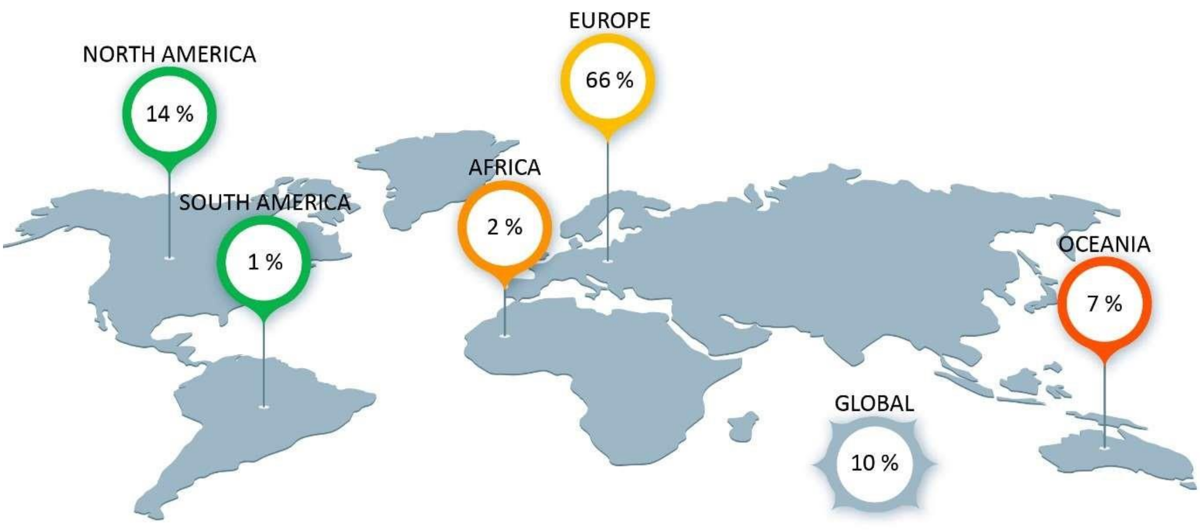
2.1 Overview of projects identified

We have identified a total of 91 projects. Out of the 91 identified projects, 20 initiatives were ultimately excluded from this document for various reasons, such as conducting participatory activities that did not qualify as citizen science, soil sampling for purposes other than assessing soil health (like isolating fungi for medicinal research or recycling food for soil improvers) or because there was insufficient information for a detailed analysis (either due to lack of availability or because they were very recent).

Thus, 71 were fully aligned with our selection criteria, or have been considered of interest to ECHO (refer to Appendix 2 for further details). These encompass projects, initiatives, or activities that actively engage citizens in soil health topics. Among these, more than half (55%) were sourced through literature review and online searches, while the remaining (45%) were incorporated through the collaborative approach and joint effort of both ECHO partners and external entities. Coordinator categories of the projects ranged from universities, government agencies, museums, associations, foundations, institutes, to NGOs or citizens, excluding possible projects coordinated by businesses or companies.

While the projects took place within and outside the EU, our search results did show geographical gaps. The geographic spread across four continents is: Africa (2%), Oceania (7%), North America (14%) and South America (1%), and Europe being the most represented (at 66%). A subset (10%) of these projects has a global scope (they carry out citizen science activities within more than one continent) (Fig. 3). With regards to the temporal coverage, the starting year ranged from 2008 to 2023, where the large majority of the projects started between 2015 and 2023.

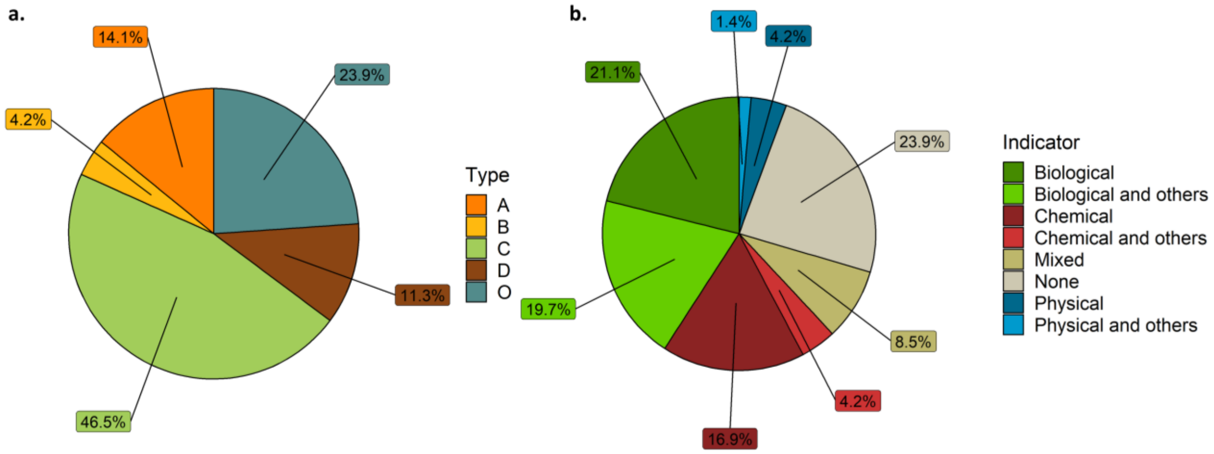
Figure 3. General geographic spread of the 71 identified projects.



Source: ECHO deliverable 1.1 (Peiro et al. 2023).

The identified projects assessed a wide range of soil health indicators (Fig. 4). The biological indicators ranged from organisms' biodiversity and characteristics (bacteria, fungi, protozoa, insects, worms or other invertebrates), to decomposition rate, and others. A large part, 21%, of the projects were exclusively centred on these indicators. The chemical indicators included, pH, soil organic carbon/matter, indicators relevant to pollution (trace metals or microplastics), and others. These indicators were the sole focus for 17% of the projects. Physical indicators included texture, structure, colour, moisture, water infiltration, temperature, and others. A small part of the projects focused on these indicators, comprising 4%. The majority of projects assessed indicators that spanned more than one category, 34%. Notably, within this mixed category, 25% lean towards one type of indicator over others (biological predominance in 20%, chemical predominance in 4% and physical predominance in 1%). Lastly, 24% of the projects did not fit the above classifications, categorized as 'no indicators'.

Figure 4. Pie charts of: a. the main project types based on public participation and soil-centric objectives, and b. soil health indicators considered within the project. Pie chart of project categories includes type 'O' whereas those of the soil health indicators does not.



Source: Adapted from ECHO deliverable 1.1 (Peiro et al. 2023).

2.2 Projects characterized by the generic, scientific and technological and citizen engagement indicators

We distinguished four main types depending on whether the degree of citizen participation (collaborative/contributory) and the main objective (soil-centric or not). These four projects were assess across all criteria. Our classification of citizen science projects offers an understanding of what each project type enables, providing a summary of their respective strengths and weaknesses.

2.2.1 Type A: soil-specific involving broader engagement

Within this category, we have classified 10 projects. These were primarily regional/city-scale projects and citizens played an active role, participating in the redesign of 2 projects and co-creating 3 others (Fig. 5). These mainly collaborative and co-created projects where coordinated by academic institutions or grower-driven. Therefore, cost, in terms of time and financial resources, to individuals and communities is high, requiring commitment and responsibility. These projects analysed chemical soil indicators like heavy metals, with toolkits that require training or expert assistance. Laboratory analysis was a crucial component in 7 out of 10 of the projects. These projects established strong communities or citizen observatories, where citizens play a significant role in project design and analysis. Three projects used applications for collecting data, where one featured a community sharing option that facilitates the dissemination of crop suggestions and practices. Target groups include growers, local citizens, researchers, and policymakers, through methods like collaborative farm-stays and the creation of living labs for engagement. The data from 6 projects are accessible online, and one project included a quality assessment framework. Notably, scientific articles were published for half of the projects. Overall, these projects yielded social, economic, and scientific impacts, influencing political aspects of land and soil management. Particularly in the social and participatory sphere, through the creation of empowered communities and knowledge transfer. Most A-type projects were short-term endeavours and were already concluded (Table 1).

Table 1. Timeline and activity for each project type at the time of reviewing. See Fig. 2 for the details on project types.

Timeline and activity	**Type A** (n = 10)	**Type B** (n = 3)	**Type C** (n = 33)	**Type D** (n = 8)
Duration $\geq$ 4 years	2	1	9	1
Duration $<$ 4 years	8	2	24	7
Ongoing status	3	2	17	4
Finished status	7	1	16	4

Source: Adapted from ECHO deliverable 1.1 (Peiro et al. 2023).

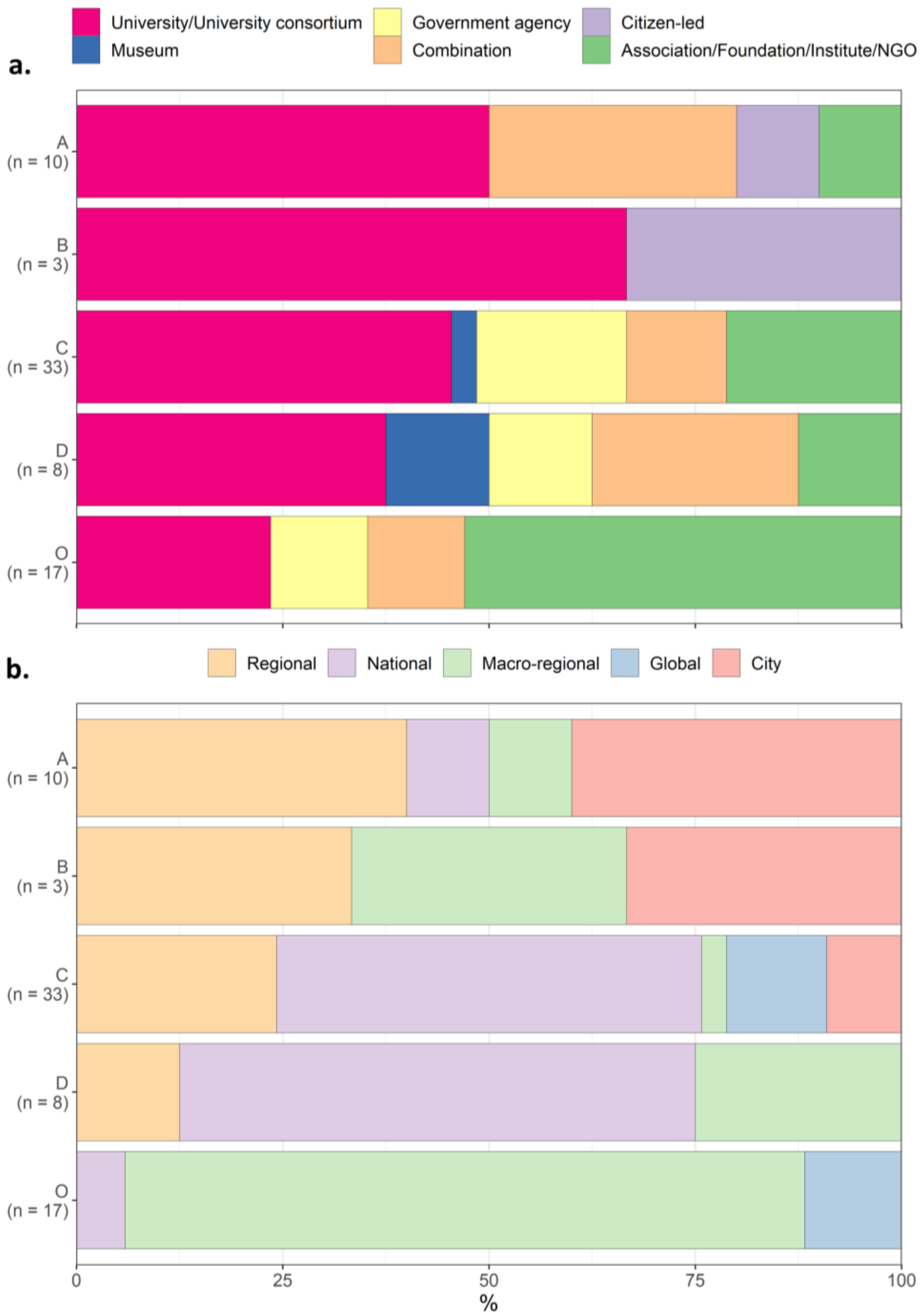
2.2.2 Type B: non-soil-specific involving broader engagement

Among all the initiatives identified, only 3 projects have significantly involved citizens in activities with non-soil-centric objectives. This category includes regional-scale projects focusing on non-soil-centric objectives but had an emphasis on soil biodiversity. They used citizen-assembled toolkits and guideline driven procedures such that citizens could carry out fieldwork independently. Furthermore, citizen contributions we integrated in both research design and data analysis. One project developed a custom application, which could be used to calculate a farm's carbon footprint, including soil health as a parameter. Target audiences were broad and included farmers and policymakers, together with diverse engagement strategies like gamification or interactive events. No publications or quality assessment frameworks are available online for these projects. Impacts of these projects spanned scientific, political, economic, social, and educational domains, through sustainable land management, urban planning, and farming practices. Type B projects were relatively short-term, with a duration of three years, and are currently ongoing.

2.2.3 Type C: soil-specific involving citizens in sampling collaboration

A total of 33 initiatives have been categorised as C-type projects, approximately half of were coordinated by academic researchers or institutions, predominantly on a national level (Fig. 5). The remaining projects were largely managed by entities and governmental bodies, extending their reach globally and regionally. The main focus of was on carrying out educational activities exploring biological and chemical aspects of soil. A notable share focussed on soil decomposition, either by use of the Tea Bag Index approach (Keuskamp et al. 2013) or through the Soil Your Undies Challenge (SYUC; 2023). In one third of the projects, citizens independently analysed samples; in another third, scientists or specialists carried out analyses. Within the remaining projects, a collaborative approach was adopted. Twelve projects have developed or leveraged applications for data processing and sharing, such as the iNaturalist platform, Jardibiodiv app, or Map my Environment. Engagement targeted a broad audience including the educational sector or rural communities, utilising workshops, exhibitions, and online resources. The outcomes 23 projects was shared online often through interactive maps on the projects' websites or applications, detailing the sample locations and associated data. These projects primarily yielded educational impacts, or generated data for research (25 out of 33), but offered limited opportunities for building community engagement, and social outcomes due to low engagement. Most C-type projects tended to be short-term endeavours, and close to half are currently ongoing (Table 1).

Figure 5. Relative distribution by project type for: a. different coordinator types that have been identified in the review, b. different geographic coverage at which the project was implemented. See Fig. 2 for details on the project types.



Source: Adapted from ECHO deliverable 1.1 (Peiro et al. 2023).

2.2.4 Type D: non-soil-specific involving citizens in sampling collaboration

Mainly national-scale projects that engage citizens in monitoring various environmental aspects. The remaining projects operate in the European region, at a macro-regional scale (covering different countries) or regional scale (Fig. 5). Nearly half of the projects were coordinated by researchers or universities. They primarily focussed on examining biological biodiversity indicators (5 out of 9), and participants were involved either in simple sample collection or in basic data interpretation. The majority of projects used toolkits comprising everyday household items such as compasses and tape measures. The remaining ones employed more intricate protocols requiring specific tubes or detectors, which were supplied by the project coordinators. Two projects have developed proprietary apps specifically tailored to their needs, such as georeferencing measurements and data collection from sensors. One used the iNaturalist platform whereas the other was custom-made. In general, the projects were of low-intermediate cost, in terms of time and financial resources, to researchers and citizens. The main target audiences were educational sectors, families, and naturalists. The results are available online for 2 projects, in the form of maps that display sample locations and related data, hosted within the projects' apps. No publications or quality assessment frameworks are available online for these projects. The project impacts included educational tools and can have economic implications, particularly in the field of agriculture. Most Type D projects were relatively short-term, averaging a span of about 2 years. The Observatoire agricole de la biodiversité (2023) projects stands apart with a duration of 14 years. Nearly half of the total number of projects are still in progress (Table 1).

2.2.5 Type O: projects of interest to the ECHO Horizon project

Out of all the projects, 17 projects did not fit into our study's selection criteria. However, they are relevant to the ECHO Horizon project and provide a broader context of projects on soil health monitoring. Although most varied in public participation, methods can contribute to evolving soil health monitoring also under citizen science projects.

Three projects aim to harmonise soil information and datasets at both global and European levels. Two of them focus on engaging experts worldwide to create harmonised and comparable datasets; one for soil physicochemical and biological properties (LUCAS), and the other on soil micro-, meso-, and macrofauna in conjunction with soil functions (SoilBON). The third is developing a monitoring framework for forest soils to support decision-making toward climate and sustainability goals (HoliSoils).

Another three projects have developed open-source tools applications. Two of them are user-friendly smartphone applications that offer decision-makers tools for assessing soil quality based on user-fed or existing data (iSQAPER, LandPKS). The third application assists in locating and describing threatened areas, sometimes in relation to soil pollution or poor land and soil management (LANDSENSE).

Another two projects stand out for creating strong communities involved in soil health or related activities. One resulted in a network of professionals sharing knowledge on the prevention and control of soil diseases (Best4Soils), and the other in a citizen community exploring urban food innovations to make cities greener, more inclusive, and environmentally resilient (EdiCitNet).

The final two projects strive to generate scientifically robust information valuable for soil health and pollution issues. One established benchmarks for multiple soil health indicators across various soils and land uses (UK-SCAPE). The other developed technology that demonstrates the feasibility of mycoremediation in decontaminating aged industrial soils (LIFE MySoil).

3 Discussion

After reviewing more than 60 projects that have engaged citizens in monitoring soil health. These initiatives aimed to gather field data for monitoring diverse conditions (Silvertown, 2009), increase the scientific literacy of participants (Bonney et al., 2009) and establish a structure facilitates decision-making processes in contemporary society (Trumbull et al., 2000).

3.1 Scope of the citizen-science project

One of the most noteworthy issues that appears from this review is that it included a low number of projects developed in low-income countries. This can be attributed both to the geographical gaps in our search results, probably as a function of our methodology to collect projects to review. For example, our limited scope excluded the community working on citizen science and the Sustainable Development Goals (http://citizenscienceglobal.org/). The potential of citizen-science projects for low-income countries high but challenging, as there is an urgent need for sustainable land management interventions to reverse degradation of natural resources (Kelly et al., 2022) and achieving progress towards the Sustainable Development Goal targets (Fritz et al. 2019). Regarding duration and timing of the reviewed projects, all of them have been developed during the last 15 years, and they are predominantly short-term, averaging 2 to 3 years in duration. The larger number of projects can be attributed to increased funding for soil-related citizen science projects or perhaps a stronger focus on dissemination of research projects, increasing their exposure online.

Clear objectives are essential for a scientific approach in citizen science projects. Our review showed that clear initial objectives regarding the scientific, technological and engagement factors are key for developing efficient methodologies and engaging citizens for the entire duration of the project. These findings are in line with Gascuel et al., (2023a). Definition of the project's scope starts by determining the soil indicators to be assessed, and sticking to them during the whole project. All types of projects (A-D) can achieve this, but certain projects from types A and B appeared to have struggled more due to the possible subjectivity of collaborative and co-created objectives. Our review confirmed that a broad suite of soil indicators can be assessed, at different levels of complexity, through all types of citizen science. Overall, our results emphasised the need for the establishment of simplified, standardised methods aimed at bridging knowledge gaps. As a result, ensuring the collection of reliable and valuable information on soil indicators; this stands with the statements of Head et al. (2020). Other projects of interest to ECHO (type O) are starting to meet a well-known need in the studied area, which is the need for robust structured soil monitoring programmes alongside citizen science programmes to provide the unbiased and statistically robust framework on which other data can be integrated (Rawlings et al., 2017; Head et al., 2020). In fact, Head et al. (2020) suggest that, until this need is not covered, citizen science approaches cannot replace statutory and traditional soil monitoring.

3.2 Data collection procedure

One major part of a robustly structured monitoring program is appropriate data collection. Particularly in the case of citizen science, appropriate data collection has been recognised as an essential component to increase trust and in generated data and therefore its use. Quality assurance of data collection should receive attention at the project design stage, such as planned use of standardized methodologies and training of participants and project managers (De Rijck et al. 2020).

A minority of projects used and published standardised citizen science procedures to soil sampling and measuring, one of them being the tea-bag index (TBI) by Keuskamp et al. (2013). The TBI allows to measure decomposition rate (i.e. biological activity) by monitoring the degradation of tea leaves buried in the soil. The TBI is an excellent example of an easy-to-use toolkit and are as scientifically accurate as alternative meticulous toolkits. In any case, successful projects implemented user-friendly designs, especially when they aimed to engage heterogeneous target groups of participants. For example, Ureta et al. (2022), where elders found difficulties in manipulating the smallest components of the biochemical toolkit used for soil-testing, forcing the project coordinators to change several designs to make them easier to manipulate and use. Good practices related to this issue, have been identified in all types of projects (A-D).

The reviewed projects used a variety of toolkits: everyday household items, lab-designed tools or specific detectors. Educational projects from types C-D suggested more homemade toolkits because they see its preparation process as an engaging activity whereas those expecting to monitor soil health periodically design tailor-made detectors, like some cases of types A and C. Another important aspect to consider when designing toolkits for monitoring soil health is the time-intensity of its use. Our review has not taken this aspect into account, but it became apparent as an important component. Head et al. (2020) affirm that time is a larger limiting factor than financial cost, but quick options for robust soil assessments are limited. There is a clear need to develop appropriate methods that are low cost and, more important, quick to implement.

Almost all projects provided guidelines for citizens to implement a toolkit in the field. Gascuel et al. (2023a) highlight that support for a gradual increase in participant skills as a point of success. These authors argue that programmes have to adapt to the infinite participant profiles and skills, and not the other way around. In our review, this approach is especially reflected in projects that mainly expected an educational impact, adapting that support to students and educators, or an economic impact, adapting it to farmers and growers' skills. When target groups are wide-spread, training is usually an obstacle since it is difficult to adapt it appropriately in accordance to every need. Therefore, citizen and stakeholder mapping and recruitment should go hand in hand with the training and support design. The already-mentioned need of standardised protocols for monitoring soil health could also be reflected in the design of these field guidelines.

3.3 Citizen engagement

Our review showed that citizen training is not limited to the provision of guidelines only. In fact, substantial improvements in projects' outcomes was reported from in-person training of citizens (present in types A and B). Projects where experts spent time with the participants during training sessions or monitoring allowed for: i.) more profound involvement of citizens into the scientific process, such as the problem definition and analysis, ii.) to create stronger communities. Ebitu et al. (2021) identified the same pattern and explained that more intense training offers opportunities for dialogue and mutual learning, beyond the limited objective of data collection. This dialogue allowed Ureta et al. (2022) to overcome the toolkit barriers found by certain citizen groups involved. Intense training also enhances experiment completion rates, stronger researcher-citizen bonds and superior data collection quality (Lovell et al., 2009; Kremen et al., 2011; Gascuel et al., 2023a). Hsu et al. (2017) also pointed out that careful training to collect data can improve data accuracy. Another suggestion to improve data accuracy is the encouragement of citizens to flag issues, which can then be followed-up through established research or policy channels. However, it is worth highlighting that these intense training methodologies in types A-B carry an important time cost, and therefore also financial cost, for the project. This entails that many short-term projects can struggle implementing them. Lastly, further research could focus on steering citizen training towards closer alignment with the stages of the EU policy cycle. For example, citizen science projects could be designed such that citizens participate throughout policy processes. In that context, citizen training should ensure accessibility of potential participants from a diverse set of backgrounds (Oturai et al. 2023).

Based on the review, we identified that initiating and maintaining the citizen motivation during projects is a common challenge. Especially in projects under types A-B, due to their special interest in constructing an engaged community. Across the projects reviewed, different methods of engaging citizens and practices in communication and dissemination have been developed, and some of them stand out for their originality, such as farm stays and podcasts in Type A. However, despite the initial enthusiasm, signs of long-term fatigue can occur amongst participants, as reported by Ramirez-Andreotta et al. (2015) and Ureta et al. (2022). The support of volunteers by qualified mediators and activity leaders is one method of mitigating issues with engagement (Gascuel et al., 2023a).

In our review, projects reported high motivation and engagement as a consequence of that participants received well-structured feedback from their scientific contributions. This trend was observed across all types of projects (A-D). Ebitu et al. (2021), also identified that data feedback protocols helped to ensure that farmers perceived results of the study as relevant. In the reviewed projects, these protocols were simplified, adapting the scientific language to leveraging appropriate communication. Citizens then can decide how to act on that information, enabling them to implement solutions at the individual level that can derive into community level. For example, the pollution-related projects allowed citizens to solve local problems, identified by the communities themselves, and to take health precautions. With this feedback, the coordinators gave recognition to citizens' scientific contributions. The recognition in turn provided meaning to the project and, therefore, boosted soil connectivity through citizen science (Pino et al., 2022; Gascuel et al., 2023a).

3.4 Database on citizen science tools

Whereas we discussed the main components of the information collected during the review, not all information has been treated in this report. We therefore refer the interested reader to the data created during this review that has been uploaded by the Ibercivis foundation on the Zenodo platform[3]. The data is also hosted on the European Soil Data Centre (ESDAC) website, in a repository dedicated to outputs from the ECHO project[4]. Long-term open access repositories to make new soil data easily findable and accessible are a key component of the Mission Soil. Given the geographic scope of the studies that were reviewed, the collected information can guide the methodology of future citizen science projects on soil health at local, national and EU levels.

3.5 Limitations of this study

Finally, we have already mentioned that this review should be considered representative rather than comprehensive, as we have found some limitations and challenges during the process. We would like to request that readers exercise caution when interpreting the data from this study, as some information may have been under- or over-estimated. For example, many citizen science projects take place outside academia and these reviews cannot be considered as a definitive search. Local or

[3] https://www.doi.org/10.5281/zenodo.10218825

[4] https://esdac.jrc.ec.europa.eu/content/soil-health-related-citizen-science-projects

community-based projects usually do not publish on established channels, and are thus difficult to trace.

4 Conclusions

The review allows for recommendations to guide future citizen science projects, and in particular ensure that ECHO contributes valuably to the field of soil health monitoring. Our suggestions are tailored to address challenges identified during the review, optimise methodologies, enhance participant engagement, and allow for ECHO to set a precedent for future citizen science endeavours. These recommendations are:

- Ensure the equal, active inclusivity of all project partners and associated citizen networks to avoid underrepresentation, as they are in countries across all income levels. This allows for diverse and balanced perspectives in the soil health monitoring initiatives.
- Leverage the extended duration of ECHO, which is above average of similar projects, to develop and implement refined scientific and citizen science methodologies.
- Inform the decision on which soil health indicators and measurements to implement by the skills and knowledge of the citizen groups expected to be involved. This will allow the program to be adapted to the participants, and not the other way around, making it appropriate for the pilot context.
- Assess the level of citizen participation in the scientific research accordingly, and therefore the type of citizen science methodology. Since ECHO expects to implement high citizen participation, different methodologies can be carried out at various scales.
- Adhere to scientific protocols whose standardisation has either been already published, is currently being established or is feasible to be determined in the future. This will ensure consistency and reliability in the methodologies employed. Collaborating with other projects focused on this issue can be key.
- Adopt a citizen toolkit that is broader than an ensemble of tools to be used for soil sample collection. In many cases the toolkit will be the only material from ECHO that citizens will receive and its potential influence on the project's impact is high. Emphasise on user-friendly, not-time-consuming and, to a lesser extent, low-cost designs.
- Appropriate management of the citizen science generated data is also a critical issue. This includes all stages, from the collection up till the processing. For example, ensuring consistent information acquisition can be achieved through a standardised description of the mode of production and anticipated use. Data scalability can facilitate use at different administrative levels. For example, appropriate sampling designs could allow scaling soil data from field-to-municipal level. A user-friendly interface that allows citizens and policy makers to analyse the results facilitate uptake and feedback from end users.
- Give support for a gradual increase in soil-related skills adapted to participants with, at least, unambiguous guidelines that are visually attractive. Complement the guidelines with in-person expert training and workshops. Assess the feasibility of employing qualified mediators, stewards or activity leaders. All these actions facilitate stronger communities and the desire to stay partially or entirely engaged with ECHO, therewith improving data collection quality and accuracy.
- Highlight simplified but accurate feedback protocols for citizens that provide them with knowledge, recognise their scientific contributions and boost soil connectivity.

- Transmit the details and impact of participation to citizens through crystal-clear initial objectives and establish solid and fluent communication channels so that every voice in ECHO, regardless of its level of participation, is heard.
- Lastly, we recommend regular impact assessments to evaluate the ECHO project's findings effectiveness in shaping soil health policies. Analysing to what extent citizen science data is integrated into policy decisions, can ensuring that ECHO's contributions are both recognized and applied in shaping sustainable soil health strategies. Close collaboration with policymakers can facilitate this integration, thus maximising the scientific and societal impact of the ECHO project.

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List of abbreviations and definitions

Abbreviations	Definitions
ECHO	Mission Soil funded project under which this review has been conducted. ECHO stands for: Engaging Citizens in Soil Science: The Road to Healthier Soils
TBI	Tea Bag Index. Citizen-science method to study organic matter decomposition in soils, first proposed in (Keuskamp et al. 2013).
ENSA	European Network on Soil Awareness
ESDAC	European Soil Data Centre

List of figures

List of tables

Annexes

Annex 1. Matrix of generic, scientific, technological and citizen engagement criteria used to review citizen-science projects

Name of the project/initiative/activity	Free response (FR)
Website	
Start year	
End year	
Location (pilots)	
Scale	Drop-down options of response (DOR): Global/Macro-regional/National/Regional /City
Coordinator	FR

SECTION 2. Scientific factors

Citizen Toolkit	List of tools for field work and/or input devices (detectors or sensors) and their technical/scientific purpose of each one (maybe based on the indicators in the next box)	FR
Specific factors	Type of soil health indicator measured (biological, chemical, physical or mixed)	
	Organisms sampled if biological properties were measured (e.g., earthworms, bacteria, fungi etc) (if required)	
	Specific chemical variables measured if samples for chemical properties were collected (e.g., nitrate, dissolved organic carbon, antibiotics etc) (if required)	
	Physical properties measured (e.g., moisture, structure, infiltration etc) (if required)	

	Specific vegetation cover type	
	Specific land use	
	Total number of samples collected during the project	

	Availability of the location of samples (Latitude and Longitude)	DOR: Yes/No
	Link to data (if accessible)	FR
	Scientific publications (if existents): Title	
	Scientific publications (if existents): DOI/Website	
Field work factors	Citizen independence during field work	DOR: People are independent/People are independent after training material/People are independent after training sessions/People depend on an expert
	Field guidelines/Training material/Training methods	DOR: Yes/No
	Link to guidelines/Training material/Training methods (if required)	FR
	Brief description of citizen soil sampling, analysing, treatment and/or storing for shipping to scientists	
Analysis factors	Responsibility for sample analysis	DOR: Citizens took it/Scientists at the lab took it/Both citizens and scientists at the lab took it
	Brief description of the scientist's analysis process (if required)	FR

	Quality assessment framework	DOR: Yes/No
	Link to assessment framework (if required)	FR

SECTION 3. Technological factors

Apps names	FR
Developer	DOR: Yes/No
Organisation Repository	FR
App found in repository	
License	FR
Operating system	
Links to sources (if existent)	
Other resources used to produce relevant data through citizen participation	

SECTION 4. Engagement factors

Target group	FR
Public participation in scientific research projects (Shirk et al., 2012).	DOR: Contributory/Collaborative/ Co-created
Engagement methods	FR
Link to impact assessment framework (if existent)	
Outstanding communication and dissemination practices	

People actively participating in citizen science or data collection

Annex 2. Citizen-science projects that were included in the review

Project name	Website	Aim	Type
BRIDGES	BRIDGES	To propose experiments, in urban and rural areas, that bring together an extended community of people, on an issue that concerns everyone closely: soil fertility.	A
Garden Roots	Garden Roots	To determine whether home garden vegetables had elevated levels of arsenic, to educate and increase community networking in resource-related issues in the community.	
GROW Observatory	GROW	A Citizen Observatory that has empowered people and whole communities to take action on soils and climate across Europe.	
HeavyMetal Citizen	HeavyMetal	To investigate heavy metal pollution in soils and crops in urban areas.	
CiDéSol	CiDeSol	To provide access to depollution techniques to professional market gardeners or citizens who cultivate polluted plots and who do not have access to industrial depollution methods.	
Using CS to develop solutions for healthy soils through phytomining	PhytoMining-Brunel	To understand good soil and generate science-based and application-oriented practices for a successful phytomining approach.	
Soils, Science and Community Action	SoilSCAN	To explore community-led solutions to soil degradation by developing and trialling citizen science protocols for community diagnosis of soil health.	
The Citizen Science Soil Health Project	CS-SoilHealth	To find local solutions to our soil health implementation conundrum using the collective knowledge of our diverse growers.	
Open Soil Atlas	Open Soil Atlas	To learn about soil quality and support policy makers in the design of the urban environment.	
Nuestros suelos	Nuestros Suelos	To design and test a toolkit for the participative assessment of soil pollution, and to make visible the existence of alternatives to traditional soil pollution assessment procedures.	
SHOWCASE	SHOWCASE	To the integration of biodiversity into farming practices, delivering innovative tools for the transition towards more sustainable farming.	B
Collectifs	Collectifs	To discover urban biodiversity and improve the design and management of common spaces for a better living environment.	
FARM NET ZERO and Farm Carbon Toolkit	Farm Carbon Toolkit	To measure, understand and act on farmers greenhouse gas emissions, while improving their business resilience for the future.	
Tea Bag Index	Tea Bag Index	Their main aim is to gather data on decomposition rate and litter stabilisation using	C
TeaTime4Schools	TeaTime		
TeaComposition Project	TeaComposition		

The Tea Bag Experiment - Tepåseförsöket	Forskarfredag	commercially available tea bags as standardised test kits, based on Keuskamp et al. (2013).	
CS project on soil health and soil awareness as part of the Science Year 2020 Bioeconomy	CS-SH Helmholtz		
TeaComposition Initiative	TeaComposition		
bodemleven	Bodemleven		
Expedition Erdreich	Erdreich		
TeaTime4App	TeaTime4App		
Soil Your Undies Challenge - University of New England	SoilYourUndies	Their main aim is to explore and investigate soil life, and soil health in general, using buried underpants, based on the Soil Your Undies Challnge.	
Plante ton slip	Plante ton slip		
Beweisstück Unterhose	Unterhose		
Alsóban az élet	ATK TAKI		
360 Dust Analysis	360 Dust	Their main aim is to map lead and other metals in home garden soils, to understand the soils and highlight the importance of healthy soils, based on the 360 Dust Analysis.	
Indiana Collaboration for Lead Action and Prevention	Lead project - Indiana		
SoilSafe Aotearoa	SoilSafe		
Latrobe Valley Dust Research	Latrobe		
Observatoire de la QUalité Biologique des Sols	QUBS	To assess the diversity and abundance of invertebrates which provide information on the state of soils.	
Bodemdierendagen	Bodemdierendagen	To go on a "benthic animal safari" and discover who lives under their feets.	
MINAGRIS	MINAGRIS	To assess the impact of plastic debris in agricultural soils on biodiversity, plant productivity and ecosystem services and their transport and degradation in the environment.	
Expedition Boden	Expedition Boden	To examine the soil in their garden and learn more about nutrients and pollutants in their soil.	
Soil Moisture Active Passive	SMAP	To validate soil moisture results measured by the community, associated to the GLOBE program.	
CALeDNA	CALeDNA	To address problems in biodiversity monitoring by pairing volunteer community scientists with researchers to collect soil, sediment, and water samples.	
Earthworm watch	EarthwormWatch	To conduct your own earthworm survey to help map where they are, better understand the vital benefits they bring, and ultimately, help protect them.	C
OPAL Soil & Earthworm Survey	OPAL	To find out more about soil and earthworms and investigate the relationships between earthworm species and habitats and soil types.	
CurieuzeNeuzen in de tuin	CurieuzeNeuzen	To investigate heat and drought and map their effects, giving advice on preserving and protecting gardens against them.	
Soil Sampling Toolkit by Citizen Science Community Resources	CSCR	To teach how to sample and test your own soil, providing tools and resources to create healthy	

		soil and gardens for healthier environments and communities.	
Programa de Conservación de Suelos	TSEA	To diagnose the health status of different soils, promote sustainable agriculture and soil health in urban areas and create a database.	
Vigilantes del Suelo	Vigilantes	To diagnose the health status of different soils, educate on its importance and create a database.	
Missourians Doing Impact Research Together	MO-DIRT	To conduct soil health surveys to collect and contribute data that will help scientists understand how soil health and soil-climate interactions are affected.	
MicroBlitz	MicroBlitz	To dig into the soil, look at the smallest building blocks of ecosystems, which is microbial DNA, and creating a map.	
Knoxville-Tennessee Environmental Soil and Stream Testing	K-TESST	To provide knowledge about soil and water quality and the health of local environments.	
Gärtnern für den Umweltschutz	IZNE-Test	To study the climate and biodiversity issues examining soils from urban green spaces.	
Citizens of the Crust: a biocrust assessment project	iNaturalist-Crust	To increase hiker awareness of biocrust, reduce crust-busting rates by hikers and gather data regarding the distribution and health of biocrusts.	
SoilSkin – La Piel Viva del Suelo	soilSkin	To know the distribution and ecological functions of biological soil covers, and to increase awarness of its importance.	
Observatoire agricole de la biodiversité	OAB	To offer protocols for observing ordinary biodiversity to interested farmers, with a view to better understanding ordinary biodiversity in agricultural environments.	
Vigie-nature école	VN-Ecole	To monitor ordinary biodiversity, involve teachers in a research program, and become students better acquainted with the biodiversity around them.	D
SCENT	SCENT	To engage citizens in environmental monitoring of land-cover/use changes and enable them to become the 'eyes' of the policy makers.	
NOCMOC	NOCMOC	To encourage citizens to get out into nature, explore meadows, observe the plants around them and infer the type of soil.	
Grower CS Project	Grower CS	To help growers face the challenges of climate extremes by improving the health of their soils linked to improved water retention and microbial function.	
MAKING SENSE	MakingSense	To show digital practices to make sense of their environments and address pressing environmental problems in air, water, soil and sound pollution.	
LANDSENSE	LandSense	To aggregate innovative technologies to empower communities to monitor and report on their environment.	O
iSQAPER	iSQAPER	To provide soil quality assessment for agricultural productivity and environmental resilience, and	

		provide decision makers with tools to manage soil quality and function.
Land-Potential Knowledge System	LandPKS	To support farmers with tools that allow them to access knowledge and information, and collect, share, and interpret their own soil, vegetation cover, and management data.
HoliSoils	HoliSoils	To tackle gaps in knowledge on forest soil processes and harmonise available soil monitoring information to support decision making towards climate and sustainability goals.
LUCAS Soil	LUCAS	To sample and analyse the main properties of topsoil and build a consistent spatial database based on standard sampling and analytical procedures.
SOIL Bon	SoilBON	To assess global drivers and functions of soil animal biodiversity and interactions in soil food webs.
Best4Soil Project	Best4SOIL	To provide information on the host status and damage sensitivity of crops for a large number of nematode species and soilborne pathogens.
EdiCitNet	EdiCitNet	To explore how urban food innovations can make cities around the world greener, more inclusive and more environmentally resilient.
UK-SCAPE programme (SOC-D project)	UK-SCAPE	To undertake research and provide data and models designed to deliver new integrated understanding of the environment to tackle those challenges.
LIFE mySoil	MySoil	To develop technology to demonstrate the feasibility of mycoremediation to remediate pollutants from contaminated soils.
Soil Health Benchmarks	BenchMarks	To create a harmonised and cost-effective framework for measuring soil health.
HuMUS	HuMUS	To engage and activate municipalities and regions to protect and restore soil health.
LOESS	LOESS	To provide an overview of the current level of soil related knowledge in different educational levels and develop teaching programmes and materials.
NBSOIL	NBSOIL	To create and test a learning pathway for existing and aspiring soil advisors.
ORCaSa - Impact4Soil	ORCaSa	A state-of-the-art platform that will collect knowledge on soil carbon and make it available to the public.
AI 4 Soil Health	AI4SOILHEALTH	To create a free app that combines AI and the latest soil health measurement techniques to help farmers and growers.
Prepsoil	PREPSOIL	To create awareness and knowledge on soil needs among stakeholders in regions across Europe.

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