European Commission

Mutual Learning Exercise

Citizen Science Initiatives – Policy and Practice

Fifth Thematic Report: Scaling up citizen science

PSF CHALLENGE

HORIZON EUROPE
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Independent
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Report

Research and Innovation

Mutual Learning Exercise on Citizen Science Initiatives - Policy and Practice Fifth Thematic Report: Scaling up citizen science

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Mutual Learning Exercise on Citizen Science Initiatives: Policy and Practice

Fifth Thematic Report – Scaling up citizen science

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SCALING UP CITIZEN SCIENCE

"[...] there is an eminent need to develop a better and more structured understanding of the context dependency and growing potential of citizen science approaches. This is both, in terms of scaling and spreading. […] Once we understand the context dependency and pathways for expansion of single initiatives, we will be able to thrive for a systemic integration of citizen science approaches into larger governance structures. This will not only allow us to support digital transitions, but also to offer opportunities for engagement in policy making and implementation. In this way, citizen science will become one important piece of the larger puzzle that will help us all to get fit for the new digital age and to contribute to a vibrant democracy".[1]

Sven Schade, Joint Research Centre, European Commission

"It is therefore time for the citizen science community to move from piloting to sustaining and upscaling successful citizen science projects starting from a reconsideration of citizen science projects' aims and business models for reasons that can be related to impact and ethics concerns".[2]

MLE CSI-PP Topic 5 Discussion Paper on Scaling up citizen science

1. Introduction

The Mutual Learning Exercise (MLE) 'Citizen Science Initiatives - Policy and Practice' (CSI-PP), initiated within the framework of the European Commission DG R&I Horizon Policy Support Facility, aims to facilitate the exchange of information, experiences and lessons learned among eleven Member States (MS) participating in the MLE, as well as to support and scale up citizen science (CS) through identifying the good practices, policies and programmes of the various approaches at local, regional and national level, towards supporting and scaling up citizen science.[3]

Despite the "Scaling Ambition"[4] of the increasing number of citizen science projects, practices and initiatives developed across Europe in the past years, many CS projects still rely on empirical pilots, aimed at experimenting with novel tools and methods. There is little empirical evidence of success factors for scaling up CS projects and limited knowledge about CS approaches and infrastructures developed across Europe in support of upscaling CS.[5] Yet, as this Thematic Report will explore, (up)scaling should not be only seen as rapid growth in size of the number of participants or the geographical area covered. Conversely, (up)scaling should be redefined according to i) more qualitative, inclusive and responsible[6] dimensions, ii) different models of and approaches to scalability, iii) the specific logics of CS projects and initiatives as well as iv) their domain and context dependency.

[1] Schade 2020
[2] Balestrini 2022
[3] https://ec.europa.eu/research-and-innovation/en/statistics/policy-support-facility/psf-challenge/mutual-learning-exercise-citizen-science-initiatives-policy-and-practice
[4] Maturano 2020
[5] Even in case of transnational CS campaigns (such as the Plastic Pirates, see Project Board #1 on page 13 of this Report), impact on policy and policymaking on a local/regional/national scale needs further investigation.
[6] The term refers to the EC RRI framework: https://rri-tools.eu/about-rri

1.1. Scope of this report

The fifth topic in the series of the MLE CSI-PP is entitled "Scaling up citizen science" and was set up to fill this gap of knowledge by drawing upon the shared experiences of the participating MS to discuss:

- challenges and success factors for scaling up CS projects on the basis of different approaches implemented in MS;
- means and willingness to contribute to the scaling up of transnational European CS campaigns.

To reach this goal, a two-day meeting was held in Berlin on 7-8 November 2022 (see section 1.2) during which the MLE CSI-PP participants discussed the topic "Scaling up citizen science" on the basis of a Discussion Paper[7] which was prepared and disseminated to participants ahead of the Berlin meeting to build collective knowledge on the topic under investigation.

This Thematic Report focuses on the meaning(s) and dimensions of scalability, drivers, success factors, challenges and best practices of scaling up CS projects in Europe, with an emphasis on the uptake for policymakers. Specifically, the aim of this Thematic Report is to share the outcomes of the three working sessions held during the Berlin meeting and provide a list of eight key areas of actions for policymakers aimed at supporting the scaling up of CS projects and campaigns across Europe.

It should be noted that the content of this report uses data stemming from the European CS landscape and CS projects initiated by European institutions (e.g., research centres, universities) and funded via institutional funding programmes. Although this is in line with the scope and purpose of the MLE CSI-PP initiative, it can also cause potential biases and limitations which are worth acknowledgment and further discussion.

1.2. Methodology

As mentioned above, the aspects of scaling up CS have been explored across three working sessions with the MLE CSI-PP participants during the meeting held in Berlin on 7-8 November 2022.

The discussions, which occurred during these three working sessions, were informed by the MLE CSI-PP Topic 5 Discussion Paper "Scaling up citizen science" which was outlined during an introductory presentation given by the Topic Expert. Specifically, the Topic Expert's presentation and the MLE CSI-PP Topic 5 Discussion Paper drew on knowledge about scaling up CS generated by the Topic Expert via 1) a literature review, 2) a survey distributed among the MLE CSI-PP country representatives and 3) interviews conducted by the Topic Expert with seven experts in CS and cognate disciplines, as detailed in the Discussion Paper "Scaling up citizen science".[8]

[7] See https://ec.europa.eu/research-and-innovation/en/statistics/policy-support-facility/psf-challenge/mutual-learning-exercise-citizen-science-initiatives-policy-and-practice.
[8] The Discussion Paper "Scaling up citizen science" is available at https://ec.europa.eu/research-and-innovation/en/statistics/policy-support-facility/psf-challenge/mutual-learning-exercise-citizen-science-initiatives-policy-and-practice.

In Berlin, the three working sessions addressed specific aspects of (up)scaling CS:

1. Definitions and dimensions of scalability;

2. Drivers, success factors and challenges of scaling up CS;

3. Policy-oriented recommendations for supporting the upscaling of CS projects and initiatives across Europe.

The participants in the three working sessions were organised in small groups and the discussions were fuelled by guiding questions provided by the Topic Expert along with indications on potential outcomes for each session, for instance, for session 1: a shared definition of (up)scaling & its dimensions for the MLE CSI-PP, for session 2: a list of assessment criteria for funding projects to scale up, and for session 3: a roadmap for the creation of policies, programmes, funding lines (see Figure 1).

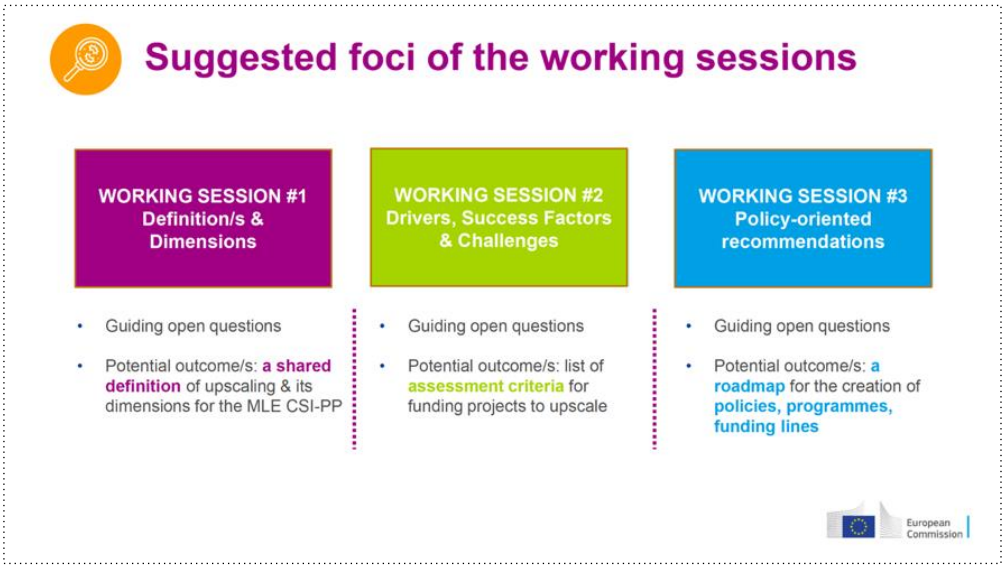

Figure 1: Suggested foci and potential outcomes of the three working sessions about “Scaling up citizen science” held during the Berlin meeting.

1.3. Structure of this Report

This Thematic Report provides a summary of key aspects about Topic 5 “Scaling up citizen science”, with a focus on the outcomes of the three working sessions. Specifically, section 2 addresses definitions, dimensions, models and approaches/strategies of scaling up CS, introduces the MLE CSI-PP Sustainable and Inclusive Scalability Framework for Citizen Science and provides a Project Board with five exemplary CS projects; section 3 outlines drivers, success factors and challenges of scaling up CS; section 4 illustrates the outcomes from the discussion about policy-oriented recommendations; and sections 5 provides eight key areas of actions for policymakers and information about the HORIZON-WIDERA-2023-ERA-01-08 call launched by the European Commission to lay the groundwork towards Europe-wide CS campaigns.

2. Scaling up citizen science: definitions, dimensions, models

2.1. Introduction

This section provides an overview of the outcomes from the literature review, the interviews with the experts and the survey conducted with the MLE CSI-PP ahead of the Berlin meeting[9] and reports the main outcomes about the definitions, dimensions, models and approaches/initiaitves of scalability in CS which emerged from the working session #1 held in Berlin.

In the literature on CS and its cognate disciplines, there is no general consensus on the meaning of scalability, its dimensions and the approaches to foster the scaling up of CS projects and the term has been underexplored or used inconsistently as a synonym of spreading or replicating. With the aim of creating a consistent framework for scaling up CS by design, Maccani and colleagues (2020) defined "up-scaling" as expanding a successful citizen science initiative in terms of both the number of participants and the geographic extent in contrast to "spreading" which can be referred to as the portability and replication of existing solutions, without a change of the actual scale of the activity in itself.

- From the interviews with the experts a general consensus emerged on the importance of distinguishing the terms scalability and spreadability, although the experts agreed that the two terms can overlap to a certain extent. Further to these general considerations, the experts highlighted several important aspects and meanings of the terms that are worth recalling here[10]:

- Replicability can be considered as a more sustainable dimension of scalability which allows an easier spreading of the projects across geographical and temporal scales[11];

- Adaptability can be a characteristic of successfully scaled-up CS projects;[12]

- Distinctive metrics are to be used for measuring the success of upscaling CS projects such as social value, impact on people's lives, qualitative growth especially in citizen engagement (in contrast to quantitative growth, and economic value/profit-based metrics usually applied for measuring the success of upscaling in the field of Entrepreneurial Innovation).

For the MLE CSI-PP participants, who responded to the survey[13] circulated ahead of the Berlin meeting, scalability can be generally associated with a growth in size and its dimensions can be associated to the geographic spread, the temporal spread, the research

[9] For further details about these outcomes see the MLE CSI-PP Discussion Paper "Scaling up citizen science" available at https://ec.europa.eu/research-and-innovation/en/statistics/policy-support-facility/psf-challenge/mutual-learning-exercise-citizen-science-initiatives-policy-and-practice.
[10] See also section 2.1 of the Discussion Paper "Scaling up citizen science" available at https://ec.europa.eu/research-and-innovation/en/statistics/policy-support-facility/psf-challenge/mutual-learning-exercise-citizen-science-initiatives-policy-and-practice.
[11] Passani 2022
[12] Passani 2022
[13] The survey and the responses are available in the Discussion Paper on "Scaling up citizen science" and its Annexes available at https://ec.europa.eu/research-and-innovation/en/statistics/policy-support-facility/psf-challenge/mutual-learning-exercise-citizen-science-initiatives-policy-and-practice.

scope, the communities engaged, the amount of data collected, the technology or methodology deployed.[14]

2.2. Outcomes from the working session #1

The MLE CSI-PP participants in the Berlin meeting were invited to further discuss the definitions and dimensions of scalability in CS, facilitated by a series of guiding questions addressing, e.g., the qualities of scalability as a construct (quantitative and/or qualitative**,** 'responsible'[15]), the metrics that policymakers should use for measuring its success, and the differences (if any) between the term scalability, replicability and adaptability (see Figure 2).

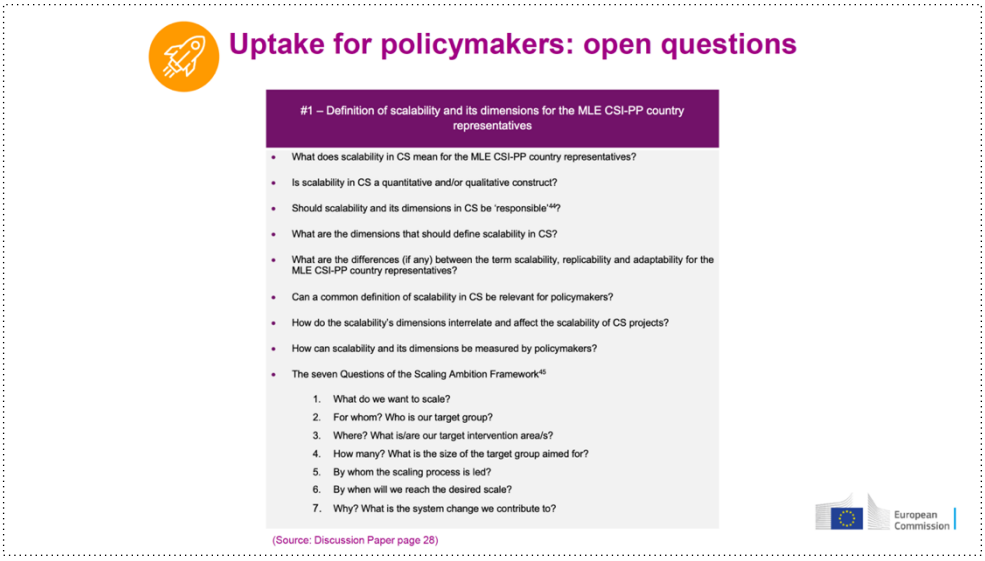

Figure 2: Guiding questions about definition of scalability and its dimensions provided by the Topic Expert to the MLE CSI-PP country representatives during the working session #1 in the Berlin meeting.

Key findings from the working session #1 addressed the following topics: i) scalability as a 'responsible' process and the logic/s of upscaling, ii) definitions and dimensions of scalability, iii) models and approaches/strategies for upscaling. These findings are summarised below in sections 2.2.1. – 2.2.4.

2.2.1. Responsible and inclusive scalability and the logic/s of upscaling

Scaling-up per se is not a value. Scaling-up is a value/ambition that suits unique types of projects, and not necessarily all projects. Therefore, it should be:

- a 'responsible'[16] and inclusive process,
- context- and domain-dependent,

[14] See also Table 1 on page 10-11 of the Discussion Paper "Scaling up citizen science" available at https://ec.europa.eu/research-and-innovation/en/statistics/policy-support-facility/psf-challenge/mutual-learning-exercise-citizen-science-initiatives-policy-and-practice.
[15] The term refers to the EC RRI framework: https://rri-tools.eu/about-rri
[16] The term refers to the EC RRI framework: https://rri-tools.eu/about-rri

- sustained by a sound logic consistent with the project/initiative,
- driven by common scientific questions and common social challenges, and
- build on proven impact, related to science and scientific literacy, inclusion, regulatory frameworks, matters of concern (e.g., environmental, societal, health).

A 'responsible' and inclusive (up)scaling process should consider the RRI dimensions[17] and account for them in the design and development of the project to align its outcomes with the values of society. For instance, it should address the gender problem or other kinds of biases towards different groups in specific projects, considering how the structural biases that exist in society actually are reflected into citizen science. Furthermore, a 'responsible' (up)scaling process, being domain- and context-dependent and aligned with the logics of the projects[18], can lead in some cases to downscale (rather than upscale) considering the capacity and the aims that exist in different projects, such as in the case of the Roadkill project (see the Project Board #5).

The reasons for upscaling should be clear and linked to the expected benefits for society and the planet. In the case of the Plastic Pirates project (see the Project Board #1), there is a common scientific question (about investigating plastic pollution in rivers) supported by a clear logic for upscaling that strengthens the project: as rivers don't follow borders it makes sense that countries in Europe can help each other. The logic for upscaling can also be regulatory, related to the existence of European legislative frameworks that require data collection, monitoring processes or the production of action plans at the European/national/regional/local level as in the case of the Hush City project (see the Project Board #4).

Certainly, to justify the upscaling, the initial project should prove to be impactful and be prepared to deal with tensions/trade-offs dependent on the types of values addressed (e.g., breadth versus depth). For instance, if the project is driven by a scientific logic (e.g., upscaling the amount of data collected involving larger samples of citizens) the expected impact is quantitative and the tasks assigned to people should be simple and easy to implement. On the other hand, if the project's aim is to sensitise citizens and grow awareness on a specific issue, the expected impact is qualitative and it might require the mobilisation of more resources (time, deepest level of engagement with citizens). However, these logics are not necessarily mutually exclusive and they can fit together, for instance like in citizen science projects working with schools, where the aggregation of hyperlocal focuses can generate impact on the local/regional/national/European level (see the case of the Plastic Pirates and the Open Street Map projects illustrated in the Project Boards #1and #2).

In conclusion, depending on the values to be addressed there might be different models of scalability and approaches to upscaling, as detailed in the following sections 2.2.3, 2.2.4, 2.3.

[17] The RRI dimensions are: public engagement, open access, gender equality, science education, ethics, and governance. Source: https://rri-tools.eu/about-rri

[18] Similarly, for citizen-generated data (CGF) projects, the Global Partnership for Sustainable Development Data noted that large-scale interventions or long-term data collections are not always needed as they depend on the CGD projects' purpose and intended users, and therefore, CGD projects scale differently according to how they organise and distribute data production (Global Partnership for Sustainable Development Data (2020) quoted in Balestrini et al. (2021).

2.2.2. Definitions and dimensions of scalabiity

It is important to have a common multi-dimension qualitative definition of (up)scaling in CS that can be used by policymakers to inform the funding schemes, define the assessment criteria and select projects to fund for being scaled up.

A common definition of (up)scaling in CS should refer to values and dimensions distinguished from the profit/economic ones, which dominate in the field of Entrepreneurial Innovation, and it should be closer to qualitative values such as those central to the Innovation Society scholarship[19] (e.g., quality of life, environmental sustainability, knowledge production and capacity building in society, creative knowledge fostered by science, inclusion and equity).

There should be a difference between scalability and replicability that can be reflected in the level of participation of citizens[20], the volume of data collected, the impact reached. Furthermore, adaptability can be considered an added value for CS projects aiming at scaling up and should be meant as the capacity of a project or an initiative to reproduce the methodology/approach/protocol on a local/regional/national/European level in accordance with the context and needs of the local stakeholder groups so as to have much more space for creativity and co-design.

These considerations supported the discussion of: i) three models of scalability (scaling up-out-deep) drawn upon scholarship in Systemic Social Innovation[21] (see Figure 3) and ii) two approaches/strategies for upscaling (top-down/deliberative and bottom up/accidental)[22], as detailed in the following sections.

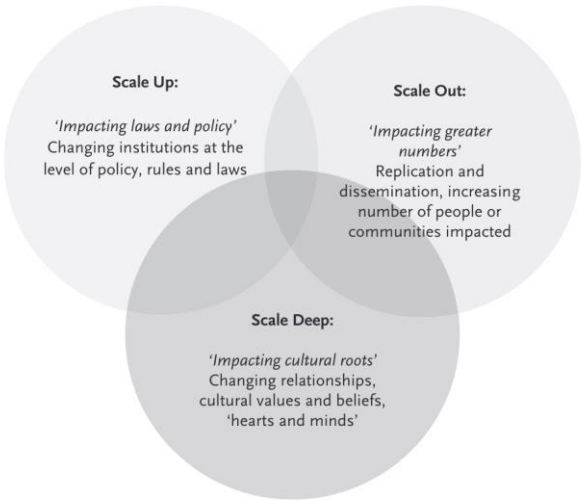

Figure 3: Scaling out, scaling up and scaling deep for social innovation. Image source: Moore, Riddell, Vocisano, 2015.

[19] Addario and Lane 2014; Passani 2022, 2014
[20] According to Haklay 2013, there are four levels of participation and engagement in CS projects: "crowdsourcing, distributed intelligence, participatory science, and extreme citizen science".
[21] See, e.g.,Westley et al 2014; Virani 2015; Moore, Riddell, Vocisano, 2015, Notably, the term 'scaling deep' was coined by Tatiana Fraser, the former Executive Director of GirlsAction as reported in Moore, Riddell, Vocisano, 2015, p. 74.
[22] Also Balestrini et al. 2021 distinguishes between the two approaches (top-down, bottom-up) using as case studies the projects Invasive Alien Species and Making Sense Barcelona.

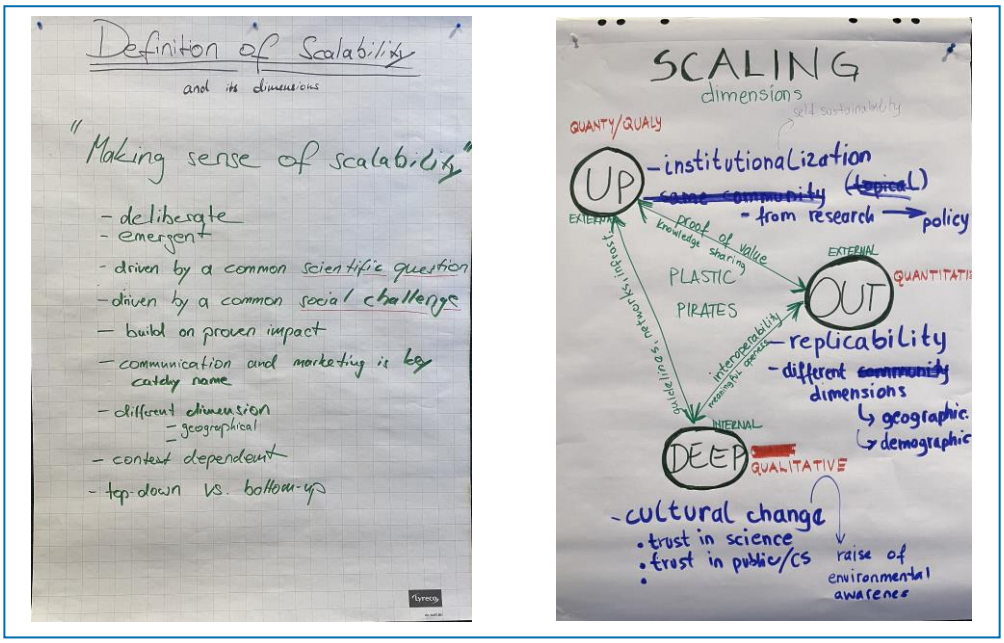

Figure 4: Samples of the outcomes from the working session #1 held during the Berlin meeting.

2.2.3. Three models of scalability: scaling up, scaling out, scaling deep

The three models of scalability discussed during the Berlin meeting (Figure 4, image on the right) stem from scholarship in Systemic Social Innovation[23] (Figure 3) and were used to unpack the implications of upscaling CS projects and initiatives, taking as a case study the Plastic Pirates project (see Project Board #1).

The scaling up model refers to institutional changes achieved through the upscaled CS projects/initiatives, which can become an integral part of a policy or an approach within a given institution or lead to policy and/or legal changes. For instance, the Plastic Pirates project, which started as a CS project in Germany, has now become part of the EU Mission: Restore our Ocean and Waters[24]. Drawing on Moore, Riddell, Vocisano (2015), strategies to achieve scaling up in CS could relate to new policy development, partnering and advocacy.

The scaling out model is mainly quantitative and refers to replication and dissemination of CS projects/initiatives, according to specific dimensions such as the geographic and the temporal spread, the research scope, the communities engaged, the amount of data collected, the technology/methodology deployed.[25] Drawing on Moore, Riddell, Vocisano (2015), strategies to achieve scaling out in CS can relate to replicating or spreading, geographically and to greater numbers, while protecting the fidelity and integrity of the CS methodologies/protocols/approaches, e.g., to ensure robust FAIR data[26] collection.

[23] See, e.g., Westley et al 2014; Virani 2015; Moore, Riddell, Vocisano, 2015
[24] https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/eu-missions-horizon-europe/restore-our-ocean-and-waters_en
[25] See section 2.1. of the Discussion Paper "Scaling up citizen science" and the slides of the Berlin meeting available at https://ec.europa.eu/research-and-innovation/en/statistics/policy-support-facility/psf-challenge/mutual-learning-exercise-citizen-science-initiatives-policy-and-practice.
[26] For a definition of FAIR data see https://www.openaire.eu/how-to-make-your-data-fair

The scaling deep model is primarily qualitative and refers to CS projects that have an impact on cultural changes and beliefs such as trust in science by the citizens and trust in citizen science by the scientists. This model is based on the recognition that culture plays a powerful role in change and "durable change has been achieved only when people's hearts and minds, their values and cultural practices, and the quality of relationships they have, are transformed."[27]

These three models are not to be considered mutually exclusive. The Plastic Pirates initiative is a good example of how these three different models can be interconnected through multiple Drivers[28] such as proof of value, knowledge sharing, interoperability, meaningful openness, and guidelines, networks and infrastructure and social/legal alignments (see the Project Board #1).

2.2.4. Two approaches/strategies for upscaling: top-down/deliberate and bottom-up/accidental.

For upscaling CS projects/initiatives two approaches/strategies have been discussed during the Berlin meeting: the top-down/deliberate and the bottom-up/accidental. For the former, there is a deliberate (political, scientific or science engagement) strategy to upscale a certain project (e.g., see the Plastic Pirates project in Project Board #1), whereas for the latter the upscaling is more organic and fostered by grassroots movements with support from local stakeholders (e.g., see the OpenStreetMap project in Project Board #2). Upscaling of CS projects/initiatives via a bottom-up/accidental approach/strategy can also be facilitated by inspiring actions and initiatives disseminated via open access platforms (such as the EU-Citizen.Science[29]). When the upscaling happens organically ('accidental upscaling'), we do not always have the knowledge about the process of scaling up. Hence, these cases should be further studied to understand the success factors and drivers underpinning these successful projects/initiatives and use this knowledge to upscale CS projects/initiatives by design.

2.3. The MLE CSI-PP Responsible and Inclusive Scalability Framework for Citizen Science

To sum up, a Framework for responsible and inclusive scalability of CS projects/initiatives composed of four models (scaling up-out-deep-down) and two approaches/strategies (top-down/deliberate and bottom-up/accidental is proposed hereafter (see Table 1). This Framework draws on the multi-dimension qualitative definition of scaling up (illustrated in 2.1.1-2.2.2), the content reported in the MLE CSI-PP Discussion Paper "Scaling up citizen science" and the outcomes from the Berlin meeting.

[27] Moore, Riddell, Vocisano, 2015, p. 74
[28] For further information about the 9-Drivers Framework, see Section 3.1.1 of this Report and section 3.1 of the Discussion Paper "Scaling up citizen science" available at https://ec.europa.eu/research-and-innovation/en/statistics/policy-support-facility/psf-challenge/mutual-learning-exercise-citizen-science-initiatives-policy-and-practice.
[29] https://eu-citizen.science/

	Top-down/Deliberate	Bottom-up/Accidental
Scaling up	Quali-quantitative change happens at the level of policy, rules, norms via a top-down approach and a deliberate strategy.	Quali-quantitative change happens at the level of policy, rules, norms, accidentally via a bottom-up approach.
Scaling out	Quantitative change happens at the level of growth (according to e.g., the geographic/temporal spread, the communities engaged, the amount of data collected, the technology/methodology deployed) via a top-down approach and a deliberate strategy.	Quantitative change happens accidentally via a bottom-up approach at the level of growth (according to e.g., the geographic/temporal spread, the communities engaged, the amount of data collected, the technology/methodology deployed).
Scaling deep	Qualitative change happens at the level of cultural changes and beliefs via a top-down approach and a deliberate strategy.	Qualitative change happens at the level of cultural changes and beliefs, accidentally via a bottom-up approach.
Scaling down	Quantitative change happens at the level of de-growth (according to e.g., the geographic/temporal spread, the communities engaged, the amount of data collected, the technology/methodology deployed) via a top-down approach and a deliberate strategy.	Quantitative change happens via a bottom-up approach at the level of de-growth (according to e.g., the geographic/temporal spread, the communities engaged, the amount of data collected, the technology/methodology deployed).

Table 1: MLE CSI-PP Responsible and Inclusive Scalability Framework for Citizen Science[30]

2.4. Project Boards

This section reports five CS projects which were discussed during the Berlin meeting as exemplary of the four models and the two approaches/strategies to scalability illustrated in section 2.2 and 2.3 of this Report, namely: Plastic Pirates – Go Europe!, OpenStreetMap, CurieuzeNeuzen, Hush City and Roadkill.

A further four exemplary CS projects are illustrated in the Discussion Paper "Scaling up citizen science", i.e., FotoQuest GO, The Star Spotting Experiment, Tea Bag Index, Dugnad for Havet (in English: Marine Citizen Science).[31]

[30] Adapted from Moore, Riddell, Vocisano 2015

[31] An illustration of these four projects can be found in Section 4 of the Discussion Paper "Scaling up citizen science" available at https://ec.europa.eu/research-and-innovation/en/statistics/policy-support-facility/psf-challenge/mutual-learning-exercise-citizen-science-initiatives-policy-and-practice.

PROJECT BOARD #1 – Plastic Pirates – Go Europe!

Figure 5: Web-based map of the Plastic Pirates. Go Europe! project. Image source: https://www.plastic-pirates.eu/en

Model and approach/strategy to scalability: Scaling up, top-down/deliberate

Project website: https://www.plastic-pirates.eu/en

Project description: Plastic Pirates – Go Europe! is a European CS campaign, in which school classes and youth groups collect plastic samples from streams and rivers, document their findings and the collected data, which are then analysed by scientists and researchers. In this way, young European citizens are making an important contribution to researching the state of European rivers and pollution caused by plastic waste. The campaign was first developed as Plastic Pirates in Germany in 2016 by the Kieler Forschungswerkstatt and partners with funding from the Federal Ministry of Education and Research (BMBF) for the Science Year 2016-17. In 2018 and 2019, the campaign was continued as part of the research focus "Plastics in the Environment" in cooperation with the Ecologic Institute (Germany). During Germany's 2020 EU Presidency, the campaign was extended to the countries of the Trio-Presidency and implemented as a joint campaign by the Ministries of Education, Science and Research in Germany, Portugal and Slovenia in 2020-2021. Since January 2022, the campaign has been expanded to the whole of Europe with the support of the EU Commission. The ERA Policy Agenda has identified Plastic Pirates as part of the ERA Action "Bring Science closer to Citizens" for the period 2022-2024.[32] As such, from 2022 to 2024, coordinated "Plastic Pirates" campaigns will take place across Europe. The Europeanisation of the Plastic Pirates Citizen Science initiative is funded by the European Commission's Research Framework Programme Horizon Europe in the area of the "Restore our Ocean and Waters by 2030 Mission". Text source: https://www.plastic-pirates.eu/en.

Lessons learned:

- Feasibility of the interconnectivity of the three models: scaling up-out-deep.

[32] https://research-and-innovation.ec.europa.eu/strategy/strategy-2020-2024/our-digital-future/european-research-area_en

- Political will, strong European partnership with Slovenia and Portugal built during the trio-presidency and support from the European Commission were key to upscaling the project and impact on the EU policy level (i.e., EU Mission Restore our ocean and waters).

- Having the local partners (e.g., schools, teachers) on board has been a great driver and is one of the priorities to further develop over the next months of the campaigns.

Box 1: PROJECT BOARD #1 – Plastic Pirates – Go Europe!

PROJECT BOARD #2 – OpenStreetMap

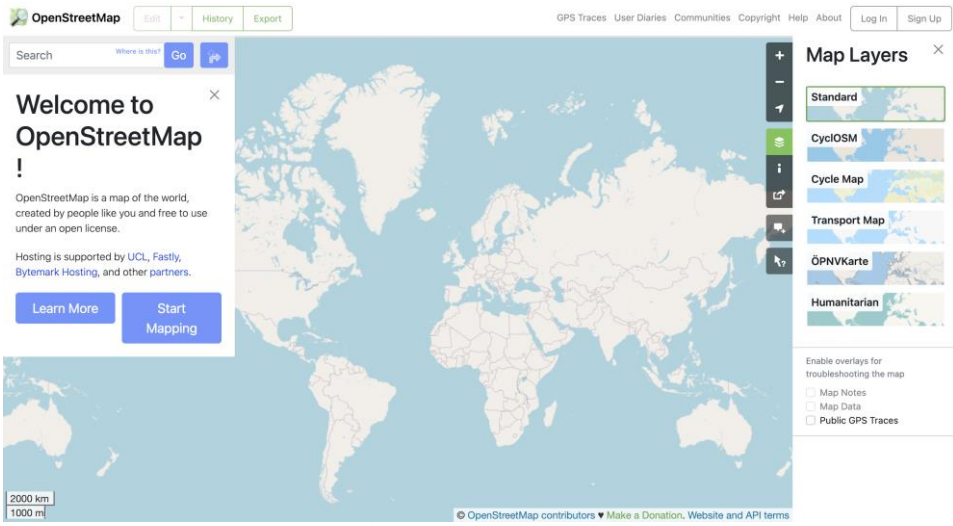

Figure 6: Web-based map of the OpenStreetMap project. Image source: https://www.openstreetmap.org/#map=2/46.1/-34.1

Model and approach to scalability: Scaling up, bottom-up/accidental

Project website: https://www.openstreetmap.org/#map=2/46.1/-34.1

Project description: OpenStreetMap (OSM) is a collaborative project to create a free editable geographic database of the world. The geodata underlying the maps is considered the primary output of the project. OSM was created by Steve Coast in the UK in 2004, and it has been inspired by the success of Wikipedia and motivated by restrictions on use or availability of map data across much of the world, and the advent of inexpensive portable satellite navigation devices. From a UK-based project in early 2000, the growth and scaling of OSM has been exponential and today it has over 6 million members and is available in 96 different languages. The OSM Foundation (OSMF) has been overseeing its development since 2006. Despite that over time it experienced issues revolving around data quality,[33] OSM today is compared to other proprietary GIS data, fuelling some of the websites we visit every day, and becoming a more and more acknowledged standard

[33] Haklay 2010

behind several GPS devices and applications. Major contributions came from communities of volunteers that input data into the system. This data is integrated with data from other sources, e.g. open government data, and initiatives, so-called Mapathon competitions, increasingly contribute by adding additional value either through improving existing maps or adding new ones. One of the most popular of OSM's features is the route planning added to OSM in 2015. Also, OSM has allowed other now popular software and applications to emerge, e.g. maps.me40, Marble4. Text source: Maccani et al. (2020), https://en.wikipedia.org/wiki/OpenStreetMap

Lessons learned:

- Effectiveness of a bottom-up approach to scaling up and application of a scaling up strategy to fostering local knowledge by setting up a bottom-up network of national and regional "Local Chapters" across several countries.[34]
- High-quality data contributed by volunteers makes OSM comparable to other proprietary GIS data and an acknowledged standard behind several GPS devices and applications.
- Several major partnerships (e.g., Yahoo! and Google sponsoring the 2007 OSM Conference) and contributions/donations (e.g., Automotive Navigation Data donating data about Dutch, Chinese, and Indian roads) appear to have been an important element for the sustainable scaling up of the project.[35]

Box 2: PROJECT BOARD #2 – OpenStreetMap

[34] Maccani et al. (2020)
[35] Maccani et al. (2020)

PROJECT BOARD #3 – CurieuzeNeuzen

Figure 7: CurieuzeNeuzen campaign in 2018. Image source: Wikimedia Commons

Model and approach to scalability: Scaling up/deep, bottom-up

Project website: https://curieuzeneuzen.be/

Project description: The CurieuzeNeuzen (Curious Noses or nosing around in Flemish) project started as a grassroots initiative in which concerned citizens in Antwerp wanted to understand the level of pollution in their city. The people behind the initiative identify passive diffusion tubes as a simple tool that can provide reliable information about the state of NO2 in their area. It started by an initiative that involved professional and interested citizens. To ensure that the results of their work are appreciated, they created a network that involved universities, the municipality and carried out crowdfunding. The first instance of measuring NO2 in 2016 involved 2000 participants, each installing diffusion tubes in their windows. Two years later, the project attracted so much interest that it was carried out across Flanders, attracting over 20,000 participants. Moreover, the Flanders environmental authorities and air quality scientists were involved in the study and in the analysis of the results, and CurieuzeNeuzen was directly referenced in the Flemish Air Policy Plan 2030. The project continues to run, and provides other environmental measurements that help in management decisions. Text courtesy of Muki Haklay.[36]

[36] See also pp. 13-14 of the MLE CSI-PP *First thematic report: introduction and overview on citizen science* available at https://ec.europa.eu/research-and-innovation/en/statistics/policy-support-facility/psf-challenge/mutual-learning-exercise-citizen-science-initiatives-policy-and-practice.

Lessons learned:

- The CurieuzeNeuzen shows that early interaction and respect between grassroots and scientists can lead to deep and lasting collaborations, which can be highly productive.
- The involvement of mass media organisation can help in providing context, information and awareness. The project has led to an increased understanding of air quality issues generally in Flanders and Belgium.
- This is an example of a project that also scaled up while scaling deep. The process of installing and dealing with the diffusion tubes provided a learning opportunity to a large number of households. The ingenious use of the sign that is used to advertise property sales for holding the sensors, also functioned as an awareness raising and publicity device.

Box 3: PROJECT BOARD #3 – CurieuzeNeuzen

PROJECT BOARD #4 – Hush City

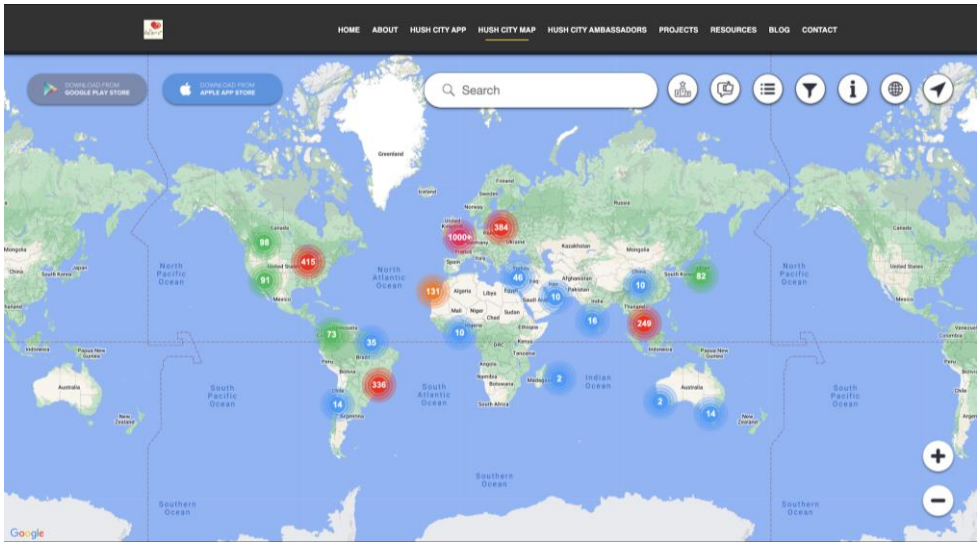

Figure 8: Web-based map of the Hush City project. Image source: https://map.opensourcesoundscapes.org/view-area

Model and approach to scalability: Scaling up/out, bottom-up

Project description: Hush City is a citizen science project in which citizens can use a free mobile app to map quiet areas in cities and collect mixed data linked to them as to create an open access, web-based map of quiet areas, with the potential of orientating research and policies, in response to issues framed by the European Environmental Noise Directive 49/2002. The collected data is then analysed by scientists and researchers, and used by policymakers who have to develop and update every five years plans for the protection of

quiet areas as a measure to reduce noise pollution in cities as per the EC Directive 49/2022. The project started in 2016 within the context of a postdoctoral Marie Curie Actions Fellowship at the Technical University of Berlin through the development of a case study in a Berlin neighbourhood set up in collaboration with the Municipality of Berlin. The Hush City app was launched in 2017 and further developed in 2018 along with the creation of the web-based app, supported by a HEAD-Genuit Foundation Grant. The project received international coverage in the media due to the relevance and timeliness of the matter of concern it addresses: high levels of noise pollution affect over 125 million Europeans every year and there is limited information about the location and provision of quiet areas in cities on a local/hyperlocal level. This accidental media coverage made the project visible internationally and raised the interests of citizens who spontaneously joined the project and contributed to scale it out and up. Since 2017, the Hush City app's users have mapped over 5700 quiet areas worldwide and collected over 130,400 mixed data associated with these quiet areas. The data is available on the mobile and the web-based versions of the app. Data generated by the Hush City users have been included in the planning and policy documents released by the Municipality of Berlin, and are under assessment by the Municipality of Limerick and Bristol. Text source: Radicchi (2021) and https://opensourcesoundscapes.org/

Project website: https://opensourcesoundscapes.org/hush-city/

Lessons learned:

- The triangulation of proof of value, matter of concern and legal alignment with the European Directive END 49/2022 contributed to the accidental scaling up/out of the project and its impact on the local policy level.
- The partnership with the Berlin Municipality from the start of the project created the conditions for the inclusion of the data collected with the Hush City app in the Berlin Plan of Quiet Areas, which is part of the 2019-2023 Berlin Noise Action Plan policy document.[37]
- Financial support for the development of the project through third-party funding – received by the Marie Curie Actions Program/TU Berlin-IPODI, the HEAD-Genuit Foundation, and Proacustica - was fundamental for the creation of the free mobile and web-based apps.

Box 4: PROJECT BOARD #4 – Hush City

[37] Senatsverwaltung für Umwelt, Verkehr und Klimaschutz. (2020)

PROJECT BOARD #5 – Roadkill

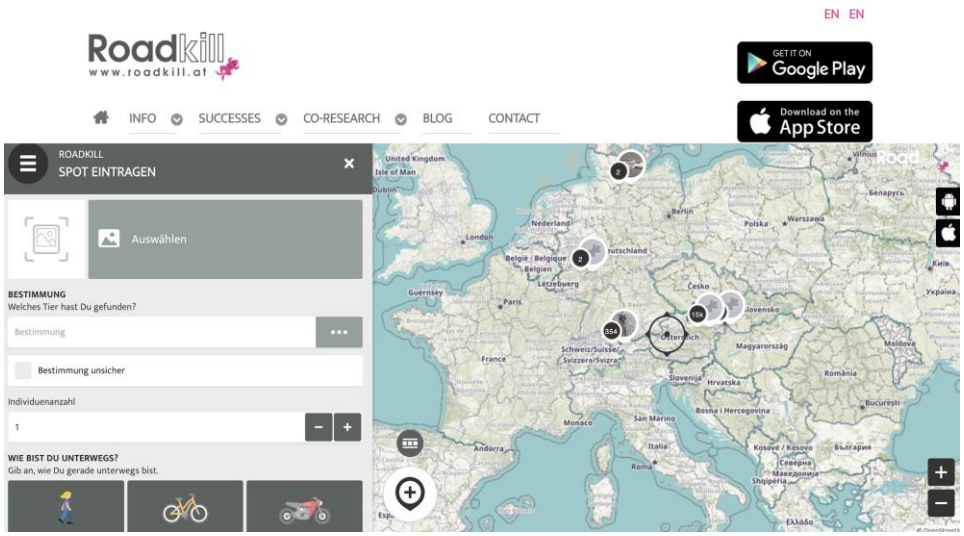

Figure 9: Web-based map of the Roadkill project. Image source: https://roadkill.at/dateneingabe-roadkill

Model and approach to scalability: Scaling down, bottom-up

Project description: Since 2014 the citizen science project Roadkill has been collecting data on roadkill with the help of citizens all over the world. The project started without external funding and was based on the voluntary work of the project team. Over the years, the project became better known and more and more citizen scientists also participated outside of Austria. They received a wide variety of animal species from all continents. This quantity and diversity pushed the small team to the limit. In order to keep the quality of the project high and to be able to meet their project goals and the expectations of the citizen scientists, they decided to focus the project on Austria in 2021. All data collected from 2014-2020 was published on GBIF and Zenodo. Background information on the data can be found in the data descriptor published in the journal Data Science. Since 2021, they are aiming to deepen the established partnerships with national NGOs and research organisations in order to be able to apply the collected data even better in science and nature conservation in Austria. In addition, they were able to establish numerous international contacts through their scientific publications, which were only possible with the help of their citizen scientists, as national roadkill projects have been set up in many countries. On the globalroadkill.net website you can find a clear overview of these projects. Text courtesy of Florian Heigl, Daniel Dörler.

Project website: https://roadkill.at/en/

Lessons learned:

- The scale down model was applied to ensure high quality standards of the project and meet the expectations of the citizen scientists' community.

- Stable institutional support for the maintenance costs of the apps/website and financial support for further developments of the project through third-party funding were key to the scaling of the project and its sustainability in the long-term.

Box 5: PROJECT BOARD #5 – Roadkill

3. Scaling up citizen science: Drivers, success factors, challenges

3.1. Introduction

This section provides an overview of the results from the literature review and the survey conducted with the MLE CSI-PP country representatives ahead of the Berlin meeting. In addition, it reports on the main outcomes about the drivers, challenges and success stories for scaling up CS projects and initiatives, which emerged from the working session #2 held during the Berlin meeting.

3.1.1. Drivers

In the literature on CS and its cognate disciplines, limited insights into the factors that influence the processes of scaling up CS projects and initiatives can be found. A valuable exception is represented by the 9-Drivers Framework to scale up citizen science « by design » developed by Maccani and colleagues.[38] This Framework is composed of:

- 3 intrinsic elements of a given CS initiative to be scaled, namely 1. Proof of value, 2. Ease of use and understanding, 3. Openness;
- 3 elements supporting the up-scaling, namely: 4. Communication and dissemination strategies, 5. Community and champions, 6. Knowledge sharing and transfer resources;
- 3 extrinsic elements of the target socio-technical context, namely: 7. Matter of concern, 8. Legal alignment and 9. Social alignment.

3.1.2. Success factors and challenges

The responses to the survey circulated among the MLE CSI-PP country representatives were analysed against the 9-Drivers Framework. The key findings resulting from this analysis highlighted the non-linearity of the association between the success factors, challenges and the elements of the 9-Drivers Framework.[39] Specifically:

- Responses provided as success factors and challenges could be associated with 1. Proof of value, 4. Communication and dissemination, 5. Community and Champions, 6. Knowledge sharing and transfer of resources, and 9. Social alignment.

[38] Maccani et al. 2020
[39] See Table 2 on p. 15 ff. of the Discussion Paper on “Scaling up citizen science” available at https://ec.europa.eu/research-and-innovation/en/statistics/policy-support-facility/psf-challenge/mutual-learning-exercise-citizen-science-initiatives-policy-and-practice

- Responses provided only as challenges could be related to 8. Legal Alignment (e.g., data/tech interoperability).

- No responses could be related to 2. Ease of use and 3. Openness.

- Notably, some of the success factors and challenges reported by the MLE CSI-PP country representatives could not be associated with any of the 9 Drivers. For instance:

  - Success factors: sustainable funding of the campaign, citizen scientists' capabilities and commitment, robust and flexible project plans, availability of resources (time, personnel, funding) for the citizen scientists.

  - Challenges: availability of resources (time, personnel, funding), research integrity and high level of data quality, resistance from non-CS research per commitment.

3.1.3. Key challenges

In the Discussion Paper and during the Berlin meeting, special attention was given to three challenges that can be relevant for policymakers: i) proof of value/impact, ii) funding and iii) assessment criteria for the selection of CS projects and initiatives to be funded for being scaled up.[40]

On a general note, demonstrating **impact** from CS interventions is an acknowledged challenge,[41] reinforced by the nature of EU-funded projects which are more likely about experimenting and learning than providing proof of value.[42] Further to this, it is especially challenging to demonstrate impact for upscaling CS projects and initiatives because - as outlined in Section 2.1 - the metrics usually applied for measuring the successful scalability of projects (i.e., economic value/profit) cannot be applied to CS projects for which distinctive metrics should be identified and used such as social value, impact on people's lives, qualitative growth especially in citizen engagement.[43]

How to financially sustain the projects and their scalability is another challenge reported by the MLE CSI-PP country representatives that more broadly reflects a scarcity of specific **funding lines, programs and policies** for scaling up CS projects at the European and national level, confirmed by the literature[44] and the pool of experts interviewed.[45] Notably, Passani[46] pointed to the cascading grants mechanism supported by the EC as a potential line of funding for scaling up CS projects and describes the examples of the EU-funded ACTION and IMPETUS[47] projects as illustrations of this funding mechanism. Contrary to this,

[40] These key challenges emerged from the analysis of the outcomes form the literature review, the interviews with the experts and the survey circulated among the MLE CSI-PP country representatives. See the data reported in the Discussion Paper on "Scaling up citizen science" available at https://ec.europa.eu/research-and-innovation/en/statistics/policy-support-facility/psf-challenge/mutual-learning-exercise-citizen-science-initiatives-policy-and-practice.
[41] See the Discussion Paper "Scaling up citizen science" available at https://ec.europa.eu/research-and-innovation/en/statistics/policy-support-facility/psf-challenge/mutual-learning-exercise-citizen-science-initiatives-policy-and-practice.
[42] Maccani 2022
[43] Passani, 2022
[44] Balestrini et al. (2021)
[45] The list of experts intervieweed can be found in Appendix B of the Discussion Paper "Scaling up citizen science" available at https://ec.europa.eu/research-and-innovation/en/statistics/policy-support-facility/psf-challenge/mutual-learning-exercise-citizen-science-initiatives-policy-and-practice.
[46] Passani 2022
[47] https://impetus4cs.eu/

Balestrini[48] noted that we need to reconsider CS projects' business models in order to foster a move from piloting to sustaining and upscaling successful CS projects. This shift can be achieved by 1) finding other funding sources, such as from the private sector and industry, 2) fostering knowledge transfer to industry and the commercialisation of the outcomes of the CS projects as products.

The development of "a set of clear **criteria for up-scaling national projects and initiatives**" and the identification of "**criteria for choosing EU wide campaigns**" were indicated by the MLE CSI-PP country representatives as some of the most important issues to address in the MLE CSI-PP Topic 5 Scaling up CS.[49] The responses collected through the survey circulated among the MLE CSI-PP country representatives suggested to use proof of value, matter of concern and citizen engagement as key selection/assessment criteria.[50] These responses also suggested a dependency of the selection/assessment criteria from a definition of scalability and its dimensions that should be more qualitative and value-oriented.

3.2. Outcomes from the working session #2

The MLE CSI-PP participants were invited to further discuss the definitions and dimensions of scalability in CS facilitated by a series of guiding questions addressing, amongst others, the success factors to consider for developing a roadmap for transnationally up-scaling CS projects, the role of policymakers in supporting the alignment of approaches and the increase of cooperation, the uptakes for policymaking stemming from the discussion on success factors and challenges of the exemplary up-scaled CS projects (see Figure 10).

Figure 10: Guiding questions about success factors, challenges and mitigation strategies/action plans provided by the Topic Expert to the MLE CSI-PP country representatives during the working session #2 in the Berlin meeting

[48] Balestrini 2022
[49] See Section 1 and Figure 1 of the Discussion Paper "Scaling up citizen science" available at https://ec.europa.eu/research-and-innovation/en/statistics/policy-support-facility/psf-challenge/mutual-learning-exercise-citizen-science-initiatives-policy-and-practice.
[50] For further information about The 9-Drivers Frameworks see Maccani et al. (2020), section 3.1. of this Report, the Discussion Paper "Scaling up citizen science" available at https://ec.europa.eu/research-and-innovation/en/statistics/policy-support-facility/psf-challenge/mutual-learning-exercise-citizen-science-initiatives-policy-and-practice.

Key findings from the working session #2 addressed drivers, success factors and challenges for upscaling CS projects and initiatives and are summarised below in sections 3.2.1. and 3.2.2.

3.2.1. Drivers and success factors for upscaling CS projects and initiatives

Among the drivers and the success factors for upscaling CS projects and initiatives, the participants in the Berlin meeting identified the following:

- Be supported by common objectives to reach, e.g., a combination of scientific relevance and political will.
- Be interesting, fun and recognisable (i.e., have a strong brand identity and marketing strategy).
- Draw on national or European networks.
- Acknowledge citizens' expertise, which can genuinely help with the upscaling process.
- Be timely, in terms of making sure that the project works at particular points in time.
- Build partnerships with educational organisations to have an impact on the students but also on the teachers.
- Ensure the upscaled projects still make sense to the people who helped build the initial projects and nurture the connection with the participants.
- Be ready to lose some control over the project and its methodology, especially concerning translation of protocols/toolkits in different languages.
- Be conscious of the trade-offs between the control over the project, the data outcome and impact on scalability.
- Make the protocols/toolkits adaptable to and easy to implement in different local contexts.

Furthermore, it was suggested that success factors can be dependent on the interests and values of the stakeholders involved in the projects such as scientists, citizens, policymakers and RFOs (see Figure 11). For instance, for scientists, elements of success can be related to building trust and getting closer to the citizens, issues of communication and language, and higher scientific impact. Conversely for the citizens, they can align with higher social relevance of the research, social trust and democracy development.

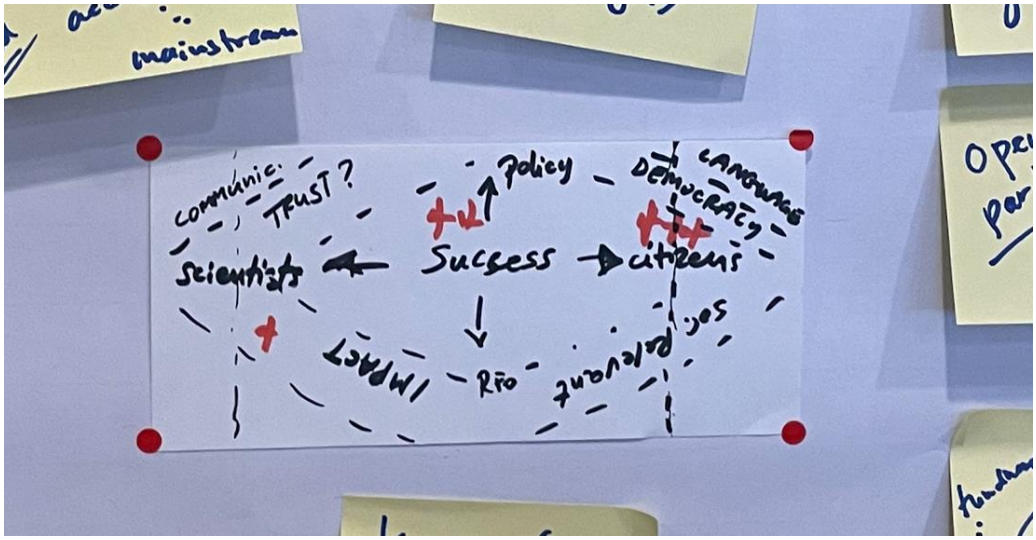

Figure 11: Sample of the outcomes from the working session #2 held during the Berlin meeting

3.2.2. Challenges for upscaling CS projects and initiatives

Amongst the most pressing challenges identified by the participants in the Berlin meeting was the question of the scientific reputation of citizen science, localisation of funding for upscaling projects at the larger EU or federal level, and lack of political will and engagement of people locally. In the following section policy-oriented recommendations are provided to address these challenges and favour the creation of an enabling environment for the successful upscaling of CS projects and initiatives. Further drivers, success factors and challenges emerging from the literature and the survey conducted with the MLE CSI-PP country representatives can be found in the Discussion Paper "Scaling up citizen science".[51]

4. Scaling up citizen science: policy-oriented recommendations

This section provides the main outcomes which emerged from the working session #3 addressing i) policy-oriented recommendations and ii) evaluation criteria that can be applied by policymakers for selecting projects/initiatives that could be scaled up.

4.1. Outcomes from the working session #3

The MLE CSI-PP participants in the Berlin meeting were invited to reflect on the implications of scaling up CS for policymakers, facilitated by a series of guiding questions addressing, e.g., the meaning of innovation in CS, criteria that can be applied by policymakers for selecting CS projects to be up-scaled transnationally, and funding mechanisms that can be developed by policymakers for supporting the upscaling of CS projects and initiatives (see Figure 12).

[51] See the Discussion Paper "Scaling up citizen science" available at https://ec.europa.eu/research-and-innovation/en/statistics/policy-support-facility/psf-challenge/mutual-learning-exercise-citizen-science-initiatives-policy-and-practice.

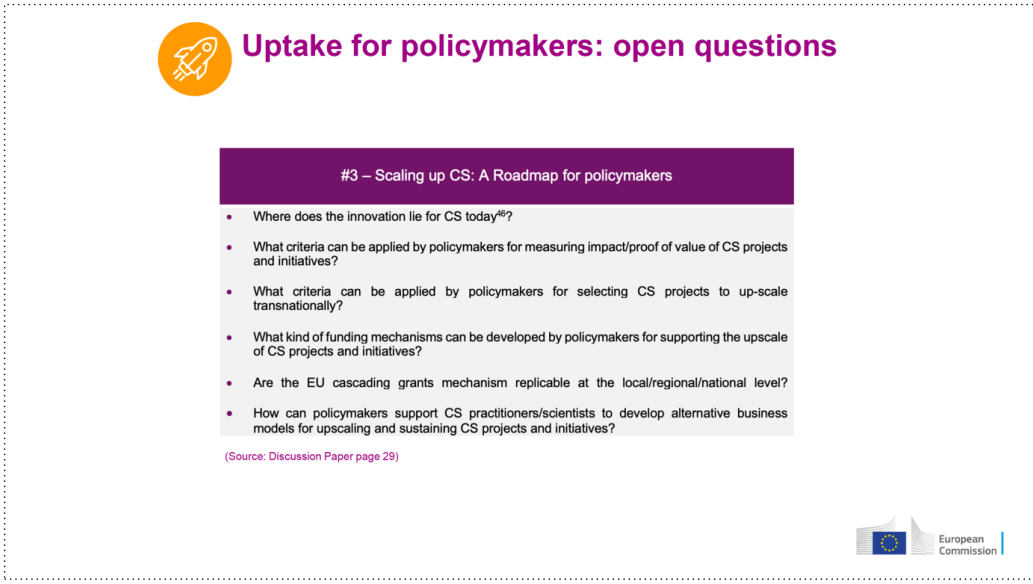

Figure 12: Guiding questions about a roadmap for policymakers provided by the Topic Expert to the MLE CSI-PP country representatives during the working session #3 in the Berlin meeting.

Key findings from the working session #3 are summarised below in sections 4.1.1 and 4.1.2.

4.1.1. Recommendations for policymakers to support the (up)scaling of CS projects and initiatives[52]

- Promote awareness of citizen science and reinforce its scientific recognition, providing more incentives for scientists and involving them as Ambassadors to showcase CS best practices and advocate against misconceptions about citizen scientists.

- Develop a chain of national/European networks and parties to foster collaboration, support networking, gather experiences and share resources and lessons learnt to prevent projects being fragmented, taking advantage of existing CS platforms.[53]

- Consider working/collaborating in advance with other countries on the cultural transformation/s and implications expected via the upscaled CS projects/initiatives.

- Diversify the sources/types of funding, e.g., using flash grant pots associated with fellowships/grants, innovation taxes, cascading grants mechanisms, venture capital/seed funding mechanisms (e.g., via prototype-proof of concept-market mechanisms).

- Ensure the allocation of specific funds for translation of protocols/toolkits of the CS projects to be upscaled.

[52] During the discussions which took place in the Berlin meeting, the importance of distinguishing between the policymakers, who operate at the political level, and those, who work at the implementation level within research funding organisations or administrations was highlighted. However, there was not enough time for discussing tailored recommendations according to these two types of policymakers. Thus, the list of recommendations illustrated in Section 4.1.1. are meant for both political and operational policymakers.
[53] Such as the EU-Citizen.Science platform https://eu-citizen.science/

- Ensure the funding mechanisms/sources can be visible to CS grassroots/bottom-up projects and create an enabling environment to support their scalability.

- Be flexible about extension of projects' timelines: if a CS project is scaling up, it might need to use the money for a longer period of time.

- Refer to the use of citizen-generated data in policymaking/policies/directives to support citizen science upscaling.

- Adopt a quali-quantitative definition of scalability which accounts for the triangulation of the Drivers proof of value, matter of concern and legal alignment.

- In line with the adopted definition of scalability, define specific evaluation criteria for selecting CS projects/initiatives to be scaled up (see section 4.1.2. below).

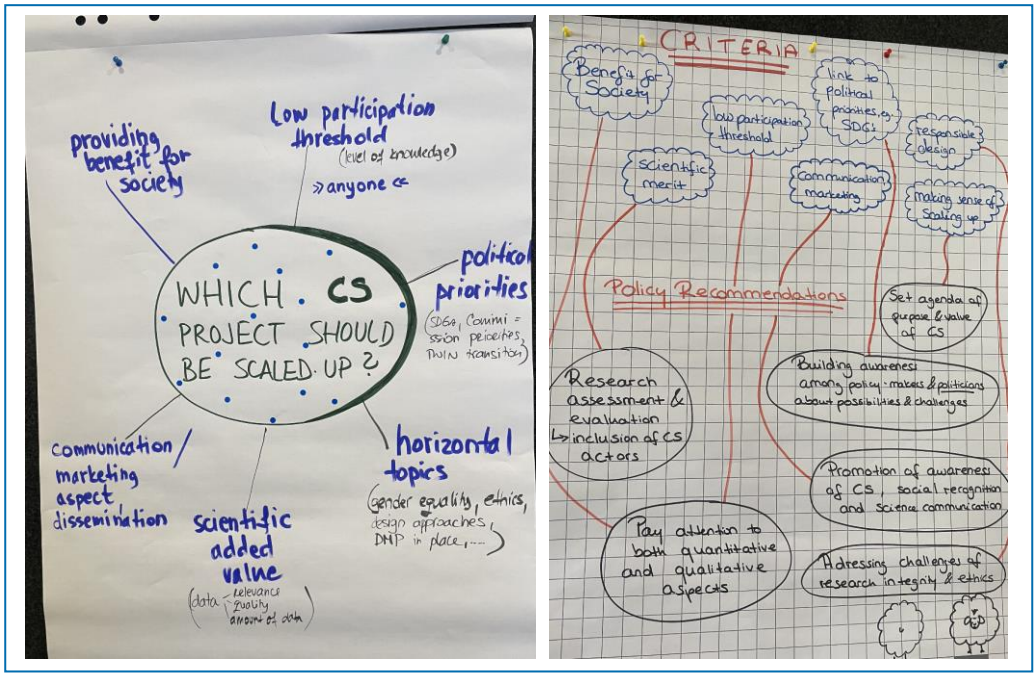

Figure 13: Samples of the outcomes from the working session #3 held during the Berlin meeting.

4.1.2. Evaluation criteria that can be applied by policymakers for selecting CS projects/initiatives to be scaled up

- Innovation as a criterion needs to move beyond the equation new=innovative and acknowledge as innovative the processes of reproducing/sustaining/(up)scaling successful CS projects and initiatives.

- Research excellence as a criterion needs to account for excellence in context, acknowledging that citizen science and citizen involvement is one of the forms of excellence in research.[54]

- Evaluation criteria should be domain specific, as in the case of projects across CS and health.

- Evaluation criteria should be qualitative and quantitative and account for the triangulation of the Drivers proof of value, matter of concern and social/legal alignment.

- Further quali-quantitative evaluation criteria can include, e.g., proof of value, matter of concern, scientific added value, social and legal alignments (such as national/EU/global strategies like SDGs, the EU Missions, the ERA, legal instruments/regulatory frameworks).

- Quantitative criteria can assess, e.g., the growth in size according to the geographic spread, the temporal spread, the research scope, the communities engaged, the amount of data collected, the technology or methodology deployed, scientific literacy/publications produced.

- Inclusion of the RRI dimensions, e.g., research integrity, gender and ethics, in the project plan to ensure responsible and inclusive (up)scaling.

- An adaptable and replicable project scheme with data management tools to ensure scalability across Europe.

- Low participation thresholds to ensure everyone can actively participate in the project independently from their level of education.

- Foreseen business plans for sustaining the upscaled projects.

- Strong communication and marketing strategies involving communities on the local level.

- Exploitation of the citizen-generated data to influence policy making at the local/regional/national/EU level.

5. Conclusion

This Thematic Report illustrated definitions, dimensions, models and approaches/strategies of scalability as well as drivers, success factors and key challenges of upscaling CS projects and initiatives. This Report drew on original content generated through a mixed methods approach combining findings from i) a literature review, ii) interviews conducted by the Topic 5 Expert with key experts in the field of CS and cognate disciplines, iii) a survey with the MLE

[54] See also the Agreement on Reforming Research Assessment promoted by the Coalition for Advancing Research Assessment (CoARA) available at https://coara.eu/

CSI-PP country representatives[55] and iv) three working sessions held in the Berlin meeting with the MLE CSI-PP participants.

It outlined the main outcomes of Topic 5 consisting of a multi-dimension qualitative definition of scaling up in citizen science, the MLE CSI-PP Responsible and Inclusive Scalability Framework, and nine exemplary citizen science projects and initiatives. To conclude, it recommends eight key areas of action for polcymakers aimed at supporting the (up)scaling of citizen science projects and initiatives across Europe.

5.1. Eight key areas of action for policymakers

Building on the original content presented in the Discussion Paper "Scaling up citizen science" and in this Thematic Report, eight key areas of actions for policymakers are identified, as follows:

1. **Rethink the meaning of Innovation in CS** acknowledging that today innovation in CS stands in the processes of reproducing/sustaining/upscaling successful CS projects and initiatives.[56]

2. **Adopt and promote a multi-dimension qualitative definition of scalability** which stems from the triangulation of proof of value, matter of concern and social/legal alignment and, according to this definition, define specific evaluation criteria for selecting CS projects/initiatives to be scaled up.

3. **Ensure responsible scaling-up** addresses the RRI dimensions[57] and ensure they are accounted for in the design and development of the projects/initiatives to align outcomes with the values of society.

4. **Commit to 'People First' (up)scaling processes**, acknowledging the importance of keeping people central and connected in the process of scaling CS projects/initiatives and taking action to remove the systemic barriers impeding people from actively participating in science producing 'contextualised knowledge' on the local/regional/national/EU level.[58]

5. **Support a Responsible Scaling Ambition**[59] in CS by designing specific funding programs and mechanisms, diversifying the sources/types of funding, and ensuring the funding lines and sources can be visible to CS grassroots movements and bottom-up CS projects/initiatives.

6. **Support the implementation of different models (up-out-deep-down) and approaches/strategies (top-down/deliberate, bottom-up/accidental) of scalability**, acknowledging scalability in CS is context- and domain-dependent and should be responsible, inclusive and aligned with the logics of the projects/initiatives.

[55] Results from the literature review, the interviews and the survey can be found in the Discussion Paper "Scaling up citizen science" available at https://ec.europa.eu/research-and-innovation/en/statistics/policy-support-facility/psf-challenge/mutual-learning-exercise-citizen-science-initiatives-policy-and-practice.
[56] Schade 2022
[57] The RRI dimensions are: public engagement, open access, gender equality, science education, ethics, and governance. Source: https://rri-tools.eu/about-rri
[58] Irwin (1995); Skarlatidou & Haklay (eds) (2021)
[59] Adapted from the term "Scaling Ambition" from Maturano (2020)

7. **Develop local/regional/national/European networks** to foster collaboration and initiate discussions about the cultural transformation/s and implications expected via the scaled projects, with an emphasis on the language issue and its cultural and scientific implications.

8. **Support the exploitation of citizen-generated data from (up)scaled CS projects/initiatives** integrating them in policies and policy making programs at the local/regional/national/EU level.

5.2. Laying the groundwork towards Europe-wide citizen science campaigns

At the time of writing this Thematic Report, the European Commission launched the HORIZON-WIDERA-2023-ERA-01-08 call[60] *Laying the groundwork towards Europe-wide citizen science campaigns*, which allocates a budget of EUR 3 million for the topic. The scope of the call is to support actions to conduct preparatory work for the launch of Europe-wide citizen science campaigns involving quadruple helix stakeholders under the new ERA and in synergies with the EU Missions. Notably, the action aims to support ERA Policy Agenda action 14 to bring science closer to the citizens and has an emphasis on involving citizens from lower socio-economic groups across potentially all ERA countries.

[60] Horizon Europe - Work Programme 2023-2024 *11. Widening participation and strengthening the European Research Area*

6. References

Addari, F. and Lane, D. A. (2014), Naples 2.0 – *A social Innovation Competition*, Report for Unicredit, quoted in Loretta, L. and Passani, A. 2014. A Hitchiker 's guide to digital social innovation, 20th Biennial Conference of the International Telecommunications Society (ITS): "The Net and the Internet - Emerging Markets and Policies", Rio de Janeiro, Brazil, 30th November-3rd December, 2014, International Telecommunications Society (ITS), Calgary.

Balestrini, M. (2022). Interview with Antonella Radicchi, August 3 2022 (via Zoom).

Balestrini, M., Kotsev, A., Ponti, M., Schade, S., (2021). Collaboration matters: capacity building, up-scaling, spreading, and sustainability in citizen-generated data projects. *Humanity Soc Sci Commun* 8, 169. https://doi.org/10.1057/s41599-021-00851-5.

Global Partnership for Sustainable Development Data (2020). *Choosing and engaging with citizen-generated data: a guide*. https://www.data4sdgs.org/resources/choosing-and-engaging-citizen-generated-data-guide.

Haklay, M., (2010). How good is volunteered geographical information? A comparative study of OpenStreetMap and Ordnance Survey datasets. *Environment and planning B: Planning and design*, 37(4), pp.682-703.

Haklay, M. (2013). Citizen Science and Volunteered Geographic Information: Overview and Typology of Participation. In: Sui D., Elwood S., Goodchild M. (eds) *Crowdsourcing Geographic Knowledge*. Springer, Dordrecht. https://doi.org/10.1007/978-94-007-4587-2_7

Irwin, A., (1995). *Citizen Science. A Study of People, Expertise and Sustainable Development.* Routledge.

Lehner, P. (2022). Interview with Antonella Radicchi, July 27 2022 (via Zoom).

Loretta, L. and Passani, A. (2014). A Hitchiker 's guide to digital social innovation, 20th Biennial Conference of the International Telecommunications Society (ITS): "The Net and the Internet - Emerging Markets and Policies", Rio de Janeiro, Brazil, 30th November-03rd December, 2014, International Telecommunications Society (ITS), Calgary.

Maccani, G. (2022). Interview with Antonella Radicchi, July 12 2022 (via Zoom).

Maccani, G., Goossensen, M., Creus, J., Righi, V., Balestrini, M., European Commission, Joint Research Centre, (2020). *Scaling up citizen science: what are the factors associated with increased reach and how to lever them to achieve impact*.

Maturano, J. M. (2020). *Responsible Scaling of Citizen Science projects for farmers: developing a SDGs-guided Toolkit*. Technical Report. IIASA.

Moore, M.-L., Riddell, D., Vocisano, D., (2015). Scaling Out, Scaling Up, Scaling Deep: Strategies of Non-profits in Advancing Systemic Social Innovation. *Journal of Corporate Citizenship* 2015, 67–84. https://doi.org/10.9774/GLEAF.4700.2015.ju.00009

Passani, A. (2022). Interview with Antonella Radicchi, July 27 2022 (via Zoom).

Radicchi, A. (2021). Citizen science mobile apps for soundscape research and public space studies. Lessons learned from the Hush City project. In Skarlatidou, A., Haklay, M. (eds) *Geographic Citizen Science Design: No One Left Behind*, UCL Press, pp. 130-148. DOI: 10.2307/j.ctv15d8174.14 ISBN: 9781787356122.

Schade, S. (2020). Foreword, in Maccani, G., Goossensen, M., Creus, J., Righi, V., Balestrini, M., European Commission, Joint Research Centre, 2020. *Scaling up citizen science: what are the factors associated with increased reach and how to lever them to achieve impact*.

Schade, S. (2022). Interview with Antonella Radicchi, June 29 2022 (via Zoom).

Senatsverwaltung für Umwelt, Verkehr und Klimaschutz. (2020). *Lärmaktionsplan Berlin 2019–2023- Anlage 10: Ruhige Gebiete Und Städtische Ruhe- Und Erholungsräume*. Berlin.

Skarlatidou, A., Haklay, M. (eds), (2021). *Geographic Citizen Science Design: No One Left Behind*, UCL Press. DOI: 10.2307/j.ctv15d8174.14 ISBN: 9781787356122.

Virani, A., (2015). *Scaling Out, Scaling Up, Scaling Deep: Advancing Systemic Social Innovation and the Learning Processes to Support it*, The J. W. McConnell Family Foundation.

Westley, F. R., Antadze, N., Riddell, D.,Robinson, K.and Geobey, S. (2014). Five configurations for scaling up social innovation: Case examples of nonprofit organizations from Canada. *The Journal of Applied Behavioral Science*, 1-27.

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This Report addresses meanings, dimensions, models and approaches/strategies of scalability in citizen science as well as drivers, success factors and challenges of (up)scaling citizen science projects and initiatives across Europe. It provides a multi-dimension qualitative definition of scaling up, the MLE CSI-PP Responsible and Inclusive Scalability Framework, and eight key areas of action for policymakers aimed at supporting the (up)scaling of citizen science projects and initiatives across Europe.
Ultimately it argues that (up)scaling should be a responsible and inclusive process, context- and domain-dependent, aligned with the logics of the projects/initiatives, driven by common scientific questions and common social challenges, and built on proven impact, related to science and scientific literacy, inclusion, regulatory frameworks, and matters of concern (e.g., environmental, societal).

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