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Citizen Science Initiatives – Policy and Practice

Thematic Report: Ensuring Good Practices and Impacts

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Mutual Learning Exercise on Citizen Science Initiatives - Policy and Practice
Second Thematic Report: Ensuring Good Practices and Impacts

European Commission
Directorate-General for Research and Innovation
Directorate A — ERA & Innovation
Unit A.1 — European Semester & Country Intelligence
Contact (Horizon Europe PSF coordination team):
Magda DE CARLI, Head of Unit A.1
Stéphane VANKALCK, PSF Head of Sector, Unit A.1
Annamaria ZONNO, PSF Team Leader & Coordinator of the MLE on Citizen Science, Unit A.1
Michael ARENTOFT, Deputy Head of Unit, A4
Gabriella LEO, Policy Officer, A4
Email Magda.DE-CARLI@ec.europa.eu
Stephane.VANKALCK@ec.europa.eu
Annamaria.ZONNO@ec.europa.eu
RTD-PUBLICATIONS@ec.europa.eu
European Commission
B-1049 Brussels

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Mutual Learning Exercise on Citizen Science Initiatives – Policy and Practice

Second Thematic Report: Ensuring Good Practices and Impacts

Written by the Independent Expert: Rosa Arias

Contributing authors:

Muki Haklay
Antonella Radicchi

2022 Directorate-General for Research and Innovation EN

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LIST OF ABBREVIATIONS

CS: Citizen Science

CSI-PP: Citizen Science Initiatives - Policy and Practice

DG: Directorate-General

ECSA: European Citizen Science Association

ERA: European Research Area

EC: European Commission

EU: European Union

MLE: Mutual Learning Exercise

MS: Member States

R&I: Research & Innovation

RRI: Responsible Research and Innovation

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EXECUTIVE SUMMARY

According to the programme of the Mutual Learning Exercise (MLE) 'Citizen Science Initiatives - Policy and Practice' (CSI-PP), the overall goal of this second topic in the series is to **identify and discuss practical examples and best practices of citizen science and its related impacts**.

Citizen Science (CS) broadly refers to the active engagement of the general public in scientific research. It is a growing practice in which scientists and citizens collaborate to produce new meaningful knowledge aligned with societal needs and challenges, applicable to any research field, including social sciences and humanities. It entails different strategies, methodologies and phases of research in which citizens can participate or get actively involved up to different levels[1]. The overall landscape of different practices makes it difficult to come up with a unique definition of CS[2]. The *European Citizen Science Association* (ECSA) adheres to a definition taking into account the participation of the general public in scientific processes through an open and inclusive approach and its use for societal benefit and decision-making processes. ECSA has also developed the 10 Principles of Citizen Science[3] and the Characteristics of Citizen Science[4], which guides practitioners in the implementation of CS projects. By promoting citizen's participation in science and in different EU policies, the recommendations in this report directly contribute to the European Commission's (EC) priorities for open, transparent and participatory decision-making, including better regulation[5], open data[6], and the EU's implementation of the Aarhus Convention[7].

In addition, CS is included as one of the eight pillars of the European's Union (EU) Open Science policy and the European Research Area (ERA), which intends to position open science as the *modus operandi* of modern science, and seeks as an ultimate goal that "The general public should be able to make significant contributions and be recognised as valid European science knowledge producers"[8].

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[1] Skarlatidou, A., & Haklay, M. (2021). Citizen science impacts pathways for a positive contribution to public participation in science. Journal of Science Communication, 20(06). P22-Motivations_Skarlatidou_Haklay_2020_ECSA_Poster.pdf (ecsa-conference.eu)

[2] Haklay M., Dörler D., Heigl F., Manzoni M., Hecker S., Vohland K. (2021). What Is Citizen Science? The Challenges of Definition. In: Vohland K. et al. (eds). The Science of Citizen Science. Springer, Cham. https://doi.org/10.1007/978-3-030-58278-4_2

[3] ECSA (European Citizen Science Association). 2015. Ten Principles of Citizen Science. Berlin. http://doi.org/10.17605/OSF.IO/XPR2N

[4] ECSA characteristics of Citizen Science: https://zenodo.org/record/3758668#.YhZJCt_MI2w

[5] https://ec.europa.eu/info/law/law-making-process/planning-and-proposing-law/better-regulation-why-and-how_en

[6] https://digital-strategy.ec.europa.eu/en/policies/open-data

[7] https://unece.org/environment-policy/public-participation/aarhus-convention/introduction

[8] Open Science | European Commission (europa.eu)

There is still a lot of room for public authorities to make use of this source of information and for CS projects to have a greater impact on policies. The current availability and amount of smartphones, internet, apps, portals, low-cost sensors and other devices is increasingly facilitating the involvement of a very large number of citizens in near real-time data gathering in citizen science projects to produce shared results. Nevertheless, challenges and barriers such as data quality and validation, scientific recognition, demonstrated impact and sustainability, among others, seem to hold back the whole potential of CS. More capacity building and training, new funding opportunities and schemes, clustering and networking, and institutional changes to recognise the practices are still needed to further support new and ongoing CS initiatives and their practitioners to open-up science to society. The recommendations in this report aim to address these challenges.

Chapter 1 of this report presents the examples of successful CS national projects chosen by the 11 countries participating in the MLE, and the variables against which the projects were analysed. **Chapter 2** summarises the results related to challenges & mitigation strategies with the implementation of CS projects. **Chapter 3** analyses the examples of CS networks and centres of expertise and presents the current state of national funding opportunities that were provided by the 11 participating countries in the MLE. **Chapter 4** provides recommendations, which cover a range of potential actions targeting different aspects discussed during the MLE workshop sessions to better implement and support CS initiatives and projects and overcome the detected barriers. The document concludes with **Chapter 5** which provides a brief description of the next MLE meetings.

As we will see, the wide range of this sample selection of CS best practices, national observatories and funding opportunities demonstrate that a so-called "successful" CS project depends on many aspects, such as the project objectives, the resources available, and the definition of the variables and its measurement to evaluate the extent to which the expected objectives and impacts are achieved. As there are no correct answers and one solution may not fit all, the selection of 11 CS projects considered as successful by the participating countries based on different reasons aims to illustrate the wide range of possibilities and the variability when selecting the different characteristics and variables that define the practice of CS. Challenges to implementation were identified for all variables, and thus a wide range of potential mitigation actions and examples of existing mechanisms to support the implementation of CS projects across Europe was examined to inform decisions on potential actions. The analysis of the different variables conducted during Topic 2 will also set the basis for further work for the upcoming topics within this MLE on CS.

1. Citizen Science in Practice

The current increase of CS projects in the different EU countries clearly shows the growing participation of society in research and science[9]. However, scientists, research organisations, and funding agencies are still discovering the benefits of increased collaboration between scientists and society, and a lot of barriers for its implementation, at the institutional and at the implementation levels, are still to be overcome.

As we have seen in the first MLE report[10], the range of activities, levels of engagement, different goals, and specific cultural issues make the practice of CS a multidimensional and complex one; and as a result, difficult to define in specific terms. There is, however, the wide EU definition of CS which includes the "voluntary participation of non-professional scientists in research and innovation at different stages of the process and at different levels of engagement, from shaping research agendas and policies, to gathering, processing and analysing data, and assessing the outcomes of research"[11]. This definition allows one to apply different frameworks and mechanisms in CS practice according to the different goals, needs and specific fields.

Within the "Topic 2: Mutual Learning Exercise on Good Practices on Citizen Science and their Impact" meetings, we shared different visions on how to do good CS – while also discussing what "good" CS means. In order to do so, each participating country representative was asked to select a CS project in their country that they considered successful in some way. Then, a project representative was asked to fill out two surveys[12] with a set of questions categorised in the following sections: (1) General information, (2) Level of participation, (3) Engagement strategies, (4) Data collection and data quality, (5) Communication strategies, and (6) Project impact and sustainability.

Once we had all the information gathered through the surveys, we placed the answers in a Miro[13] board, using some visualisation metaphors, such as a traffic light, a battery, or a target, so that participants could see their answers together with all the other participants' answers in a way that was friendly, easy to

[9] Moedas, C. Innovation in Open Science, Society and Policy. Pag V. Retrieved from: https://www.jstor.org/stable/pdf/j.ctv550cf2.2.pdf?refreqid=excelsior%3A7d6d324dccf1bc033034611dc6e03a07&ab_segments=&origin=

[10] European Commission, Directorate-General for Research and Innovation, Haklay, M., Mutual learning exercise on citizen science initiatives: policy and practice. First topic report, Introduction and overview of citizen science. Horizon Europe policy support facility, 2022, p 32.

[11] European Commission, Directorate-General for Research and Innovation, *Citizen Science : elevating research and innovation through societal engagement*, Publications Office, 2020, https://data.europa.eu/doi/10.2777/624713

[12] Hanington, B., & Martin, B. (2019). *Universal Methods of Design, Expanded and Revised*. Beverly, MA: Rockport Publishers. ISBN-13: 978-1631597480.

[13] Miro (2022). https://miro.com/index/

understand and not overwhelming (as a lot of information was collected)[14]. This Miro board allowed us to perform an interactive workshop divided into two sessions, with a tailored methodology based on three main approaches: (1) co-creation[15], (2) collaborative research[16], and (3) horizontal evaluation[17].

Co-creation is an approach in which the generation of value does not fall on a single company or organisation, but rather on different stakeholders from different areas of knowledge who generate it from direct collaboration. On the other hand, collaborative research consists of researching "with", and not "on". And finally, horizontal evaluation is a process that mixes self-evaluation with external evaluation. The methodology that was built for the sessions consisted of co-creating new knowledge (through Miro dynamics and open discussions) based on previous collaborative research (surveys), while evaluating horizontally (each country's own project and the other projects) all the information gathered. The agendas of both workshops are presented below:

Time	Description
09.30-09.40	Welcome (Alan Irwin, 5') Instructions (Gillian Kelly, 5')
09.40-09.50	Presentation: The role of CS in research and innovation: Citizen Science put into practice (Rosa Arias, 10') • The added value of CS in Open Science, Sustainability and RRI
09.50-10.25	National funding to promote Citizen Science: The case of Spain (Cecilia Cabello, Director STI Policies, Spanish Foundation for Science and Technology, FECYT, 10') • Q&A (5') • Open discussion in Miro based on the experiences compiled by the MS (Rosa Arias & team, 20')
10.25-11.20	Barriers in the implementation of successful CS projects (Rosa Arias, 10') • Interactive exercise in Miro (Rosa Arias & team) ○ Working on the challenges and potential mitigation strategies (30') ■ 15' add new challenges ■ 15' add mitigation strategies ○ Open discussion (15'):
11.20-11.30	Break
11.30-11.45	Analysing the impact of CS projects: The ACTION impact framework (Antonella Passani, T6, 10') • Q&A (5')
11.45-12.00	Examples of impactful projects: Teatime4science (Judith Sarneel, Umea University, Sweden, 7') • Q&A (8')
12.00-12.15	Examples of impactful projects: D-NOSES. Citizen science for monitoring odour pollution (Rosa Arias, 7') • Q&A (8')
12.15-12.25	Open discussion (Antonella Passani, Judith Sarneel, Rosa Arias)
12.25- 12.30	Closing and next meeting (Alan Irwin)

[14] The Expert would like to thank Carla Perucca Iannitelli, Miguel Hernández and Blanca Guasch for providing their support in collecting and compiling this information for the Report.

[15] van Boeijen, A., Daalhuizen, J., & Zijlstra, J. *Delft Design Guide*. The Netherlands: BisPublishers. ISBN-13: 978-9063695408.

[16] Wine, O., Spiers, J., Kovacs Burns, K., van Manen, M., Osornio Vargas, A. (2022). A case study unpacking the collaborative research process: Eight essential components. *Environmental Science & Policy, 131*, 209–220. https://doi.org/10.1016/j.envsci.2022.02.006

[17] BetterEvaluation (n.d.). *Horizontal Evaluation*. Retrieved April 12, 2022, from https://www.betterevaluation.org/en/plan/approach/horizontal_evaluation

Time	Description
09.30 - 09.40	Welcome (Alan Irwin, 5') A short ice breaker exercise (5', Marzia Mazzonetto)
09.40 - 10.00	Presentation of the 11 successful CS projects selected by the MS (All: 1' presentation per project, focusing on the objectives. Project leaders are invited to the session if they want to directly present their projects)

10.00 - 11.30	Miro interactive exercise including the 11 successful projects chosen by each Member State (All, 90')
	• Short presentation on the level of participation and engagement strategies (5', Rosa Arias)
	  ○ Open discussion (All, 15')
	• Short presentation on data collection and data quality (5', Rosa Arias)
	  ○ Open discussion (All, 15')
	• Short presentation on communication strategies (5', Rosa Arias)
	  ○ Open discussion (All, 10')
	• Short presentation on project impact and sustainability (5', Rosa Arias)
	  ○ Open discussion (All, 30')

11.30 - 11.40	Short break
11.40 - 12.00	Reflection on the challenges and the proposed mitigation strategies • Remembering Day 1 work (All, 5') • Open discussion: Prioritising mitigation strategies (All, 15')
12.00 - 12.20	Reflection on potential national support strategies to be adopted • Short presentation (Rosa Arias, 5') • Open discussion (All, 15')
12.20 - 12.30	Next meeting instructions (5', Gillian Kelly) Closing and next meeting (5', Alan Irwin)

Image 1: Agendas of workshops on the 7th and 14th March 2022.

The following examples of successful CS projects were chosen[18] by the 11 participating country representatives taking part in the MLE 'CSI-PP'. As we will see in the following chapters, the wide range of this sample selection of CS best practices demonstrates that there is no universal definition of what a successful CS project is, and that this will depend on the combination of variables, resources and aspects that are chosen to define the project so as to achieve its expected objectives, outcomes and impacts.

[18] See the full questionnaire in the following link: https://docs.google.com/forms/d/e/1FAIpQLSfPURlDk-suvhr8pzHFnosjD69m-GI_zpf7cOQllmcRdsMXFQ/viewform

Table 1. Examples of successful CS projects chosen by CSI-PP

Logo	Name of the project	Country	Lead institution	Start - end year of the project	Description of the project	Webpage
topotheque Our Memories	TOPOTHEK	Austria	ICARUS (International Centre for Archival Research)	2010 - ongoing	A digital database for historical content, focusing on preserving historical material kept in private hands, making it visible to the public.	https://www.topothek.at/en/
XperiBIRD.be	XperiBird.be	Belgium	Royal Belgian Institute of Natural Sciences	2016 - ongoing	Development of a tit nesting observation network in educational centres using an easy-to-use set-up.	http://xperibird.be/en/home
SPIPOLL	Spipoll[19]	France	Vigie-Nature in Natural History Museum of Paris	2010- ongoing	Recording and sharing information (photos) about plants and pollinators to support a better understanding of the relationships of plants and insects.	https://www.spipoll.org/
EXPEDITION ERDREICH	Expedition Erdreich	Germany	Helmholtz-Zentrum für Umweltforschung	2019-2022	Collect a nationwide soil dataset to provide soil knowledge and raise soil awareness in society.	https://www.expedition-erdreich.de/
ÉGHAJLATVÁLTOZÁS Nemzeti Laboratórium	Klimavaltozas	Hungary	University of Pannonia	2020 - ongoing	Explore the causes of climate change and their impacts, focused on the different social groups and actors in it.	https://klimavaltozas.org/index.php/

[19] Acronym of Suivi Photographique des Insectes Pollinisateurs (Picture based monitoring of flower dwelled insects)

	Guardiani delle Coste	Italy	ENEA (Italian National Agency for New Technologies, Energy and Sustainable Economic Development)	2019 - ongoing	Collection of data of the Mediterranean sea environmental quality targeted to students of secondary schools to preserve Italian coasts.	https://guardianidellacosta.it/
	Monica[20]	Italy	ENEA	2014 - ongoing	Use of sensors (smog tracker) to understand how citizens are exposed to air pollutants in different scenarios.	http://www.citizenscience.enea.it/progetto-monica
	UngHus	Norway	Work Research Institute (AFI) and Oslo Metropolitan University	2018- 2021	Explores how youth participation works in practical terms at municipal level, co-developing an intuitive and accessible framework for participatory methods.	https://unghus.oslomet.no/
	Keepers of the sea	Portugal	Ocean Alive (Cooperativa para a educação criativa marinha)	2019-2020	Collect data of seagrass meadows with the fisherwomen in the area to empower them and foster the recovery of those ecosystems.	https://www.ocean-alive.org/en/keepers-of-the-seagrass-meadows
	Ecomore	Romania	National Institute of Research and Development for Optoelectronics	2020-2022	A platform to report water quality issues at national level by citizens, promoting active involvement of communities in decision-making and education.	http://ecomore.inoe.ro/
	COVID-19 sledilnik	Slovenia	Scientific association Sledilnik	2020 - ongoing	The project collects, analyses and publishes data on the spread of SARS-CoV-2 in Slovenia to give the public a better overview of the pandemic.	https://covid-19.sledilnik.org/sl/stats

[20] Acronym of MONItoraggio Cooperativo della qualità dell'Aria (Cooperative Monitoring of Air Quality)

	Teatime4science	Sweden	Umeå University and the Swedish Research Council Formas	2015 - ongoing	A collaborative map to understand Global drivers of decomposition through a DIY method that consists of burying tea bags, digging them up and analysing its decay 3 months later.	http://www.teatime4science.org/

1.1. Citizen Science practice: defining variables to achieve CS project objectives and expected impacts

The definition of a CS project implies making decisions from the very beginning on a wide range of aspects. How many citizens or citizen groups would we like to engage in the project? How will we start the engagement? In which phases of research do we want to engage them? Do we need to engage other stakeholders to realise the expected impacts? Which communication strategies can help? What are the right channels and messages to be conveyed? What tools should we use to collect and analyse the data? How can we maintain citizen motivation and engagement? The answers to these questions will depend entirely on the project objectives, the resources available, and the expected impacts, and on the experience of the interdisciplinary team that will work on the project. As it was pointed out during Topic 1 of the MLE, there is not a unique definition of CS, meaning that best practices learnt from experience are key elements to be transferred to similar projects to guarantee success. In order to analyse the wide range of possibilities available, we divided the components that define a CS project into different categories, which we called "variables" and were extracted from the Challenge Paper[21]. In Chapter 2, these variables will be analysed based on the Challenge Paper, on the 11 examples provided by the participating countries and on the outcomes from the workshops organised during Topic 2.

- Variable 1: Participation, Engagement, Inclusivity & Diversity in CS across all phases of the research project
- Variable 2: Data Quality and Openness
- Variable 3: Science Communication in CS projects
- Variable 4: Demonstrating Impacts
- Variable 5: Fostering Sustainability

[21] European Commission, Directorate-General for Research and Innovation, Arias, R., Mutual learning exercise on citizen science initiatives: policy and practice. Second topic challenge paper, Ensuring good practices and impacts. Horizon Europe policy support facility, 2022, https://data.europa.eu/doi/10.2777/17212

2. Challenges & Mitigation Strategies With The Implementation Of Citizen Science Projects

2.1. Introduction

In this chapter, we summarise the results related to challenges and potential mitigation strategies that were presented in the Challenge Paper for Topic 2. The 11 participating country representatives were asked to present successful CS projects, to work on specific challenges and collaboratively analyse related variables during the workshops held on the 7th and 14th of March 2022. This chapter sets the basis for Chapter 3 (national/European schemes and initiatives to support CS practices) and Chapter 4 (recommendations), which covers a range of potential actions targeting different aspects to better implement and support CS initiatives and practitioners relating to the following challenges:

- Challenges for citizen engagement associated with Variable 1 (Participation, Engagement, Inclusivity & Diversity in CS across all phases of the research project)
- Challenges for data collection associated with Variable 2 (Data quality and Openness)
- Challenges for communication in CS projects associated with Variable 3
- Challenges for demonstrating impacts (Variable 4), including policy challenges
- Challenges for fostering sustainability associated with Variable 5

The starting point of the challenges and barriers presented for the implementation of CS projects are the result of a co-creation exercise conducted during the "Citizen Science Cluster Event 2019"[22] conducted with all the H2020-funded CS project coordinators in the Science with and for Society (SwafS) call, as explained in the Challenge Paper for Topic 2. **During the MLE sessions on the 7th and 14th March 2022, the validity of these challenges and barriers was reviewed and revised**, although it is clear that most of them are still relevant in 2022. **Mitigation strategies were also defined and their applicability and potential feasibility evaluated**.

[22] Within Session 1: "Challenges on how to enable Citizen Science to play a fuller role in Research and Innovation", Horizon 2020, Citizen Science Cluster Workshop (Brussels, 12th December 2019). Report retrieved from: https://www.innovationisrael.org.il/ISERD/sites/default/files/inline-files/Citizen%20Science%20Cluster%20Workshop_December%202019.docx.pdf.

2.2. Challenges for Citizen Engagement

This challenge has been associated with **Variable 1: Participation, Engagement, Inclusivity & Diversity in CS across all phases of the research project**, and was revised against the list of challenges presented in the Challenge Paper, which are the following:

- Challenges in increasing the number of participants within the CS Project.
- Challenges in the implementation of a real engagement of citizens in risk of social exclusion: engage all levels of society ensuring inclusivity in order to "democratise" science.
- Barriers for engagement: poverty, lack of social mobility, gender issues (females underrepresented), ethnic minorities, language barriers, etc.
- Role of citizens limited to data gathering (in comparison to their active involvement since project identification during the whole implementation cycle following an Extreme CS Approach[23]).
- Close cooperation with social and civil organisations (among others) needed (knowledge coalition) to promote social change. Need to move from top-down to bottom-up approaches.
- Motivation mechanisms for sustained engagement during the project: relevant knowledge, access to information, games, entertainment, solving a direct problem that communities may have.
- Are rewarding mechanisms needed? How ethical are they in each case?
- Do citizens participating in CS projects have internal biases?

The way that citizens take part in CS projects can range from an extra pair of hands to gather data to a much more equal partnership where citizens can help/take the initiative to set the agenda, develop scientific experiments, or do analytical work and interpret and assess the results[24]. The specific engagement approach will look very different depending on the type of project, who is going to initiate it, what the project objectives and expected impacts are, the total amount of budget and resources that are available, and what stage of development the project is at. Thus, we started by analysing the participation level and the engagement strategies used in the 11 CS projects selected in relation to Variable 1 and the related pre-identified challenges.

[23] Haklay, M., and Francis, L., (2018). Participatory GIS and community-based citizen science for environmental justice action, in Chakraborty, J., Walker, G. and Holifield, R.(eds.), The Routledge Handbook of Environmental Justice. Abingdon: Routledge, pp. 297-308.
[24] Bonney et al., 2009; Phillips et al., 2019.

Regarding the **participation level**, participating countries were asked to answer the following questions for the selected successful CS projects.

- Which role do citizens have in the project?
  - Level 1: Citizens acting as sensors
  - Level 2: Citizens acting as interpreters
  - Level 3: Active participation of citizens in data collection
  - Level 4: Citizens involved in the whole project lifecycle: from researching the problem definition, to data collection and analysis
  - Level 5: The project is led by citizens
- What citizen groups do you engage in your project? (schools, neighbours, experts, science lovers, etc.)
- How many people have you involved (approximately)?
- What are the motivations for citizens to participate in your project?

The results are provided in the form of an illustration below. The diagram can be read as follows: the first and third figure represents a battery. In the first row, a full battery represents the highest level of citizen's involvement, while in the third row, the battery represents the number of participants in a CS project (the bigger the number, the more charged the battery). Conversely, where citizens are less in numbers or less involved the battery decreases. The upper target sphere shows the number of citizen groups that are involved (a full sphere means more diversification in citizen and organisations groups involved in the CS project, while only one circle represents the involvement of a unique citizen group). The lower target shows the type of motivations identified for citizens to participate (the different circles show the number of motivations detected):

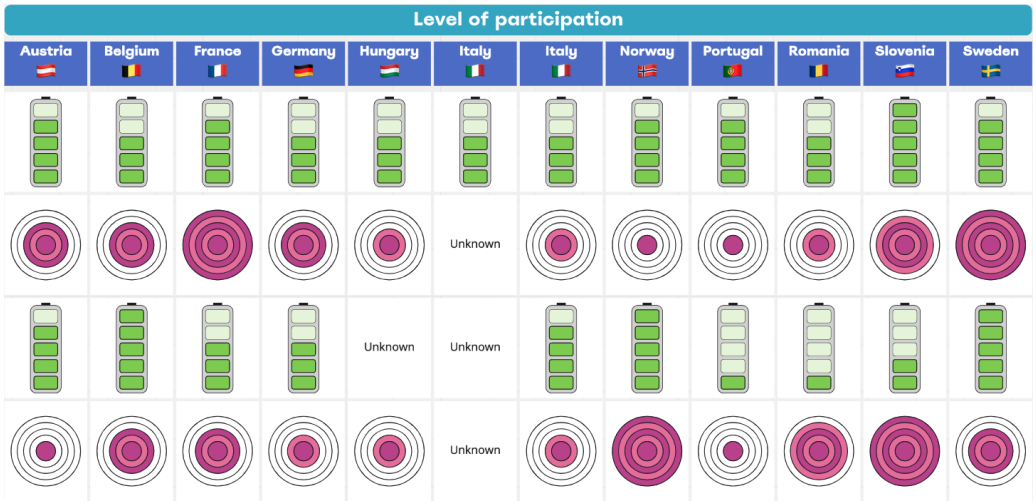


Figure 1: Illustration of the different levels of participation of the projects chosen: 1) Level of engagement; 2) Number of engaged groups; 3) Relative number of citizens engaged; 4) Number of detected motivations for participation.

The **role of citizens** can be considered active in the CS initiatives included, going from level 3 to level 5 in the classification of Extreme CS[25]. None of the projects selected consider the role of participants as sensors or interpreters (Level 1 and 2, respectively), and a majority affirm that the participants play an active role in the data collection (BE, DE, HU, IT and RO). In Austrian, French, Norwegian, Portuguese and Swedish initiatives, citizens actively participate in the whole lifecycle of the project, while only the Slovenian project (Sledilnik Covid-19) is at level 5 of participation where citizens are leading the project.

With regard to the **citizen groups** that the project aims to target, students, volunteers and science lovers are the most common groups that are engaged in the projects. It is notable that educational objectives are common in the projects that aim mostly at students and schools. On the other hand, projects whose objectives are more aligned to data collection usually pinpoint enthusiasts in the field as the targeted citizens to engage.

The **number of participants** in the successful CS projects of the 11 country representatives vary significantly from around twenty to tens of thousands. These numbers are directly related to the objectives and the groups or participants that the projects are focused on, and the feasibility and technical limitations for engagement; i.e. while the Teatime project in Sweden engaged 26,000 people through an active reach in schools to understand decomposition processes, the Ecomore project engaged a lower number of participants who were highly motivated to analyse water quality in Romania. The numbers are shown as a relative comparison between the lower and higher number of citizens engaged.

[25] For further information, visit: https://www.geog.ucl.ac.uk/research/research-centres/excites

An aspect that is frequently not taken into account is the **motivation of participants** to take part in these projects. This is an important element of every CS initiative. Among the 11 projects, several drivers for participation were identified: social interaction or "fun", learning and working with scientists, participation in data analysis and validation, a shared concern about the problem studied, protection of nature, a feeling of belonging to a community, a contribution to the common good, and a willingness to make their voice count.

Engaging citizens to any CS project is a very challenging and time-consuming task which requires enough resources and interdisciplinary knowledge. Nevertheless, it is critical and crucial to a project's success. But how deep in the project do we want to engage citizens? The questions below were asked to participating countries in order to understand the **engagement strategy** of each CS project:

- Which engagement strategies have you used for the different target groups of citizens?
- Have you considered the gender dimension in your project actions? If so, how?
- Do you use any strategy to reach hard-to-get (underrepresented) groups? If so, please describe.

The results were showcased in the form of traffic lights as follows (Figure 2). The first light illustrates the yes/no answers to the question: Have you considered the gender dimension in your project actions? While the second light corresponds to the question: Do you use any strategy to reach hard-to-get (underrepresented) groups?

Figure 2: Traffic light illustration of the engagement strategies corresponding to each project, including gender aspects (traffic light 1) and specific strategies to reach underrepresented groups (traffic light 2).

The **engagement strategies** most commonly used between the 11 successful CS projects are media campaigns (mainly social media, TV and newspapers), the webpage of the projects, direct mailing to targeted groups (including whatsapp and emails), capacity building programmes, school visits, and direct collaboration with local entities and municipalities.

Less than half of the projects studied have included a **gender perspective** explicitly in their programmes. Projects that do not include it affirm a bigger participation of women or the absence of deliberated gender bias in the resulting participation. With regard to the projects that include a gender dimension, the approaches differ significantly (also depending on the specific target groups). For example, in the Portuguese project SeaGrass Guardians', the main participants are fisherwomen, whereas Science, Technology, Engineering and Mathematics (STEM) was promoted among Belgian female students through the Xperibird project.

With regard to the use of strategies to reach **underrepresented groups** in their projects, most of the programmes do not present any specific strategy. Nevertheless, the Belgian and the Norwegian initiatives took into account inclusiveness aspects when they implemented the project in schools, such as bringing the project to remote schools or favouring access to youth that are normally absent from planning processes.

During the open discussion on the different levels of participation and engagement strategies, several important points were raised. Norway positioned the idea that, despite low levels of participation, having a map of collaboration is a good indicator of how the benefit of CS is extracted from one target group that actively collaborates with other stakeholders. In the same line, Belgium commented that this type of map facilitates the participation and the definition of engagement strategies of stakeholder groups that are remote from scientific culture. Thanks to this approach their project managed to reach different groups of people and to involve school groups. In the case of the Portuguese project, the level of participation is low in number, but high in engagement, helping women involved to become local tourist guides.

With regard to motivation, all participating countries' representatives agreed that sharing knowledge is key. Knowledge is already there, but it is enriched through different perspectives and sharing. Nonetheless, special attention should be paid to the motivation of scientists and that of the citizen scientists. What do the citizens get from the project? This point requires further consideration. For instance, if one considers the motivation to provide a public service, this seems great on the one hand; however, on the other hand, citizens expect that public services are provided and guaranteed by governments. In this regard, Belgium shared that in the XperiBird project, there is an online platform where schools can see in real time what is happening in other schools. This is an important motivation for them because it allows them to network, learn new aspects and activities and it encourages both girls and boys to get involved. Hungary followed this point by highlighting that in Klimavaltozas, young participants are addressing the Hungarian statute of participation document connecting motivation at the individual and community levels, and this makes them feel that their voice is heard. This concept is relevant and expressed in the government's policy

documents. Austria also indicated that gender needs to be better considered when working with young children by taking into account the gender dimension but also by boosting STEM careers.

To sum up, engagement strategies and participation should be valued at many levels, from occasional contributions to deep engagement in all phases of research, depending on the project objectives and expected impacts. Motivational elements should be considered as well in the set-up of a CS project, so as to maximise the value of the project for both scientists and citizen groups. Different people with different life experiences, responsibilities and interests can contribute and add value to different phases in CS projects. The optimum level of participation will vary depending on the project goals, resources, target audiences, inclusive and gender perspectives, and many other aspects. The desired level of participation will mainly depend on the project objectives, but will be strongly limited by the human resources' capabilities and budget of the research team. In such a context, flexibility is key.

2.3. Challenges for Data Collection

Challenges for data collection corresponds to **Variable 2: Data Quality and Openness**, and was revised according to the list of challenges presented in the Challenge Paper which are the following:

- Automatic data validation mechanisms are costly.
- Data is dispersed in several repositories and difficult to access and re-use.
- A data-centric approach is not systematically adopted, making it difficult to assess, measure and compare results and impact.
- Data sharing between projects is still a challenge.

In terms of **data type**, which can range from something as simple as a number, to an elaborate annotation with images and different media, this will depend on the project and discipline it covers. This first selection will determine the data collection phase, precision and accuracy aspects. In data processing, it is vital to have consistency in data sets over time. For data analysis, data sets must have adequate representation and distribution of the target population or area. Data type will later determine the reliability and validity of the whole data set. Reliability implies long-term stability and consistency of data. And the data results should be able to be replicated repeatedly. Reliability also ensures CS is trusted and aligns with policy requirements and citizen's interests. Nonetheless, CS data is valid only if it means what it is supposed to, including accuracy, confidence, completeness, and being error-free.

With regard to **data quality**, several factors should be considered. Firstly, existing CS projects have different incompatible ways of dealing with data quality,

data sharing and legal and ethical issues, hindering its interoperability. This significantly impacts the future reuse of data. Secondly, some CS projects are contributory in approach with no minimum standard or protocol in place, although most of them integrate quality analysis into their design[26]. Thirdly, most CS projects have multiple goals, and all must deal with the various legitimacy problems around them. In addition, the adoption of open data approaches can highly benefit CS by increasing its visibility and creating opportunities for collaboration, data consistency, and securing the legacy of projects and their impacts. Simultaneously, CS is a field that contributes to making research more open and participatory[27]. However, open science faces many challenges such as the lack of a structured approach that advocates for openness, and limited free access journals and open licensing of academic publications (and if opened, these represent a high cost that most CS small projects cannot afford, directly hindering scientific recognition).

The questions below were asked to participating countries in order to understand the **data quality and openness** of each CS project:

- Can you describe the dataset being collected (type of data)?
- Which methods and tools do you use for data collection? Have they been specifically developed for the project?
- How do you ensure the quality of the collected data? How do you validate it?
- Do your participants receive any training to guarantee the quality of the data collected? If so, please describe.
- Is the data produced open? Is the data produced FAIR (Findable, Accessible, Interoperable and/or Reusable)?[28]

The results were showcased in the form of lights as follows (Figure 3): The first traffic light illustrates the answers to the question: Do your participants receive any training to guarantee the quality of the data collected?, while the battery represents the level of realisation of the FAIR principles in each project.

[26] Kosmala, M., Wiggins, A., Swanson, A., & Simmons, B. (2016). Assessing data quality in citizen science. Frontiers in Ecology and the Environment, 14(10), 551-560. https://doi.org/10.1002/fee.1436; Wiggins, A., Newman, G., Stevenson, R. D. and Crowston, K. "Mechanisms for Data Quality and Validation in Citizen Science," 2011 IEEE Seventh International Conference on e-Science Workshops, 2011, pp. 14-19, doi: 10.1109/eScienceW.2011.27.

[27] Citizen science and open science – European Citizen Science Association (ECSA) (citizen-science.net)

[28] For further information visit https://www.go-fair.org/fair-principles/?msclkid=01712aa1b99411ec97dcad9ec96eff83

Figure 3: Light illustration of the data type, data collection methods, quality assurance and openness strategies corresponding to each project

Analysing the data collection of the 11 projects, the differences on the **type of data collected** among projects were noticeable, ranging from just the GPS location of seagrass (Seagrass Guardians) to qualitative and quantitative data of soil, such as land use, pH, soil colour or decomposition rate (Expedition Erdreich), or the collection of pictures of arthropods within a radius of 5 metres during 20 minutes (Spipoll). Consequently, the **methodology and tools used for collecting data** also varied between projects. Most of them centralise the data collection on a platform (webtool or mobile app), while others gather data on text files (CSV), Google Docs sheets or use commercial navigation devices. Some projects also use interviews to collect qualitative data or other means such as whatsapp, Facebook or email. None of the projects stated that their data was published on external platforms, as they already had their own tool to gather the information.

The **data quality** of the different projects is ensured through a wide range of validation methodologies, including technological and IT means. In some cases, the community of participants check the validity of the data in a crowd validation process (e.g. Topotheque), while in other cases the data collected is directly validated and studied by experts (e.g. Guardiani della Costa). In some cases, comparison with official data is also put in place (COVID-19 sledilnik).

With regard to the **training of the participants**, there is also a lot of variability between the projects, presumably due to the differences in the data collection complexity. For instance, the Spipoll project does not have any dedicated training as the collection methodology does not need it. On the other hand, projects such

as XperiBird or Seagrass Guardians provide tutorials at the beginning of the project. In addition, other projects offer different training workshops to the participants, learning by doing sessions with researchers, or use Trainer of Trainees approaches between the participants.

Finally, with regard to the characteristics of the data, all the projects have **open data**, so it is available to the public and can be published without restriction. In addition, four projects follow the FAIR principles (Findable, Accessible, Interoperable and Reusable).

During the open discussion, several important points were raised by participating countries confirming that data quality of CS projects is one of the most challenging aspects. In this regard, as data collection takes time and effort, a participant highlighted that achieving policy impact is particularly challenging since it happens at the end of the project, even years after its finalisation, and requires long-term datasets. Therefore, there are few mechanisms to report its success and policymakers need to be more aware to go further and sustain projects in the long run.

Slovenia also explained that their selected project was particularly successful because it combines official data with its own visualisations and interpretations derived from citizen generated data. Moreover, for the Slovenian public institutions, it was paramount that the project produce FAIR data to facilitate its official uptake. In fact, the project has been so successful that the same approach is now being replicated to gather climate data, which will help to sustain the project and reuse all the work done for different purposes.

2.4. Challenges for Communication

This section corresponds to **Variable 3: Science communication in CS projects**. The variable was revised against the list of challenges presented in the Challenge Paper, which are the following:

- To have specific knowledge and enough resources for devoted personnel.
- To have specific communication plans to reach the target citizens and any other stakeholder group from the quadruple helix to get involved[29] - and enough resources for their implementation.
- To choose and use proper media channels, communication strategies

[29] To know more, the NEWSERA Project is co-creating innovative science communication strategies with 38 CS projects in Italy, Spain and Portugal through #CitSciComm Labs to reach quadruple helix stakeholders. The first findings have been published in the NEWSERA Policy Briefs for each stakeholder group (citizens, academic scientists, policy makers, and industry and SMEs) and can be downloaded from Zenodo. The final conclusions will be published as blueprints at the beginning of 2023. https://zenodo.org/record/5533911#.Ym_ridpByUm.

and targeted messages for each stakeholder group.
- To have proper plans and resources to engage with citizen's public events, scientific or policy-makers' events.
- To provide regular feedback to the citizens engaged in the CS project to maintain their motivation and engagement.

One of the pivotal characteristics of CS is the public involvement of citizens in scientific research. Communication and dissemination are therefore essential to the success of any project and its impact: from recruiting citizen scientists, to keeping them engaged throughout the whole project lifecycle, to the dissemination of the project together with the stakeholders involved. However, this requires taking into account many aspects such as the variety of stakeholders and their motivations, the selection of relevant communication channels for each of them, the definition of targeted messages, the use of co-creation exercises to understand their concerns, needs and communication strategies, and many more. In CS, no communication and dissemination strategy is static: they must be adjusted and updated according to the life cycle of the project and its specificities. However, communication represents one of the main challenges for projects due to the amount of time, effort and technical expertise it takes to communicate well within the different phases of the project (e.g. recruitment, engagement and dissemination) and the necessary adaptation of the communication strategies, messages and channels to the targeted citizens groups and stakeholders. Communication should also be monitored and evaluated throughout the whole project, reviewing and updating resources constantly, and specific knowledge in science communication is required (and not always available in the implementation teams, usually due to a lack of resources).

The questions below were asked to participating countries in order to understand the science communication plan of each CS project:

- Is there a specific communication plan to reach the target citizens? Or any other actors from the quadruple helix (i.e., academia, public sector, private sector)? Are there dedicated personnel or specific resources for this?
- Which media channels were used?
- Was participation or engagement with public events included in the project?
- Was regular feedback provided to the citizens engaged? If so, how?

The results were showcased in the form of lights and targets as follows: The traffic lights illustrate the yes/no answer of participants corresponding to the first,

third and fourth question and country, while the target shows the variety of channels each CS uses. The more channels used, the bigger the target is.

Figure 4: Light illustration of the communication strategies corresponding to each CS project: 1) Communication plans; 2) Media channels used; 3) Participation in public events; 4) Feedback provided to citizens.

In response to the setting of specific communication plans, all the projects answered affirmatively except one, targeting mainly the potential participants (schools, naturalist NGOs, general public, etc.) but also in some cases aiming at scientists or municipalities. While in some cases there are dedicated personnel or communication agencies dedicated to the dissemination and communication of the projects, in other cases, it relies on participants and project managers. Facebook and Twitter are the preferred social media used for communication, while other media channels used by the projects are the project webpage, national TV programs and radio broadcasts. Furthermore, most of the projects also engage with the public through diverse public events, such as workshops, information days, exhibitions, the Researchers' Night, roundtable discussions, congress and science communication events. The projects tend to collaborate with municipality stakeholders, youth and science associations to increase the number of events they participate in and their outreach. They also noted the difficulties that the COVID-19 pandemic situation[30] had on the public dissemination of their initiatives and on the participatory and data collection activities. However, projects made an effort to provide regular feedback to

[30] To know more about how the pandemic affected science communication practices, please check this joint publication from the 8 SwafS-19 projects working on science communication funded under the H2020 programme: Roche, J., Arias, R., Bell, L., Boscolo, M., Fornetti, A., Knutas, A., Kupper, F., Magalhães, J., Mannino, I., Mendoza, I., Moreno-Castro, C., Murphy, K., Pridmore, J., Smyth, F., Tola, E., Tulin, M., Weitkamp, E., Wolff, A. Taking Stock and Re-Examining the Role of Science Communication (2021). Front. Environ. Sci. Opinion article. https://doi.org/10.3389/fenvs.2021.734081

participants through newsletters, regular meetings and the sharing of scientific results of the project.

During the open discussion on science communication in CS projects, several important points were raised by participating countries. On the one hand, Belgium shared the Youtube channel of the project where children upload videos made by themselves. Besides, they are currently gathering feedback and information from other countries and schools that wish to replicate the project in their territories, making it replicable and highly collaborative. On the same line, the German project presented also has a Youtube channel, where local groups discuss the topic and bring forward new issues and materials. The communication is not centralised, making the project run smoothly. Finally, the Slovenian project is also currently communicating their results to the wider public and policymakers, using the data and showcasing in media channels.

2.5. Challenges for demonstrating Impact

This section corresponds to **Variable 4: demonstrating Impacts**, and was revised according to the list of challenges presented in the Challenge Paper which are the following:

Challenges for demonstrating Impact

- Explore new impact & evaluation metrics that embrace new social dimensions (including ethical aspects and socially responsive research) as well as indicators to demonstrate impact within science, policy, society and economy.
- Use co-creation and participatory settings to develop new evaluation collaborative approaches.
- Create indicators to measure the impacts of citizen science (i.e. get inspiration or use the ACTION framework[31]).
- Create indicators at the adequate level (local, regional, national, European) that can be easily measured to demonstrate impact.

The impact of CS initiatives is usually divided in four core elements: Scientific, Socio-ecological, Political and Economic. A significant amount of impacts within CS projects are achieved after the data collection and analysis phase, especially the policy impact that tends to be realised in the medium to longer term, while funding is rarely extended beyond this point. Overcoming this obstacle by ensuring larger funds that take into account the amount of time and resources needed to develop a proper impact (social, economical, political, scientific and

[31] Passani, A., Janssen, A., Hölscher, K (2021). Impact assessment framework. DOI 10.5281/zenodo.3968459

environmental) framework is of utmost importance for the sustainability and real-life impact of CS projects.

The social impact of CS relates to the democratisation of science by providing access to knowledge production to boost social innovations, which therefore creates effective relationships between scientists and society. Besides, CS projects can definitely create a positive environmental impact in: 1) supporting environmental management, 2) providing evidence for policy, 3) behavioural change of participants towards pro-environmental actions, 4) social network championing, 5) political advocacy, and 6) community change. With regard to the economic impact, setting up collaborations among citizens, policymakers, the civil society sector (non-governmental organisations and other civil society organisations) and the private sector (SMEs and industries) involves a certain level of trust which requires time. Where this level of trust between society and policymakers does not exist, the private sector can play a key role by mediating and engaging both sides. Their involvement can also contribute to the sustainability of CS projects by creating new business models that further support the activities. There are also opportunities for participants to learn new skills and even, in rare cases, create new tools and services that can become valuable in their own right, and contribute to job creation.

Despite countless improvements during the last two decades, some actors of the scientific community remain reluctant to recognise CS as a legitimate scientific approach. This is sometimes fuelled by a lack of sufficient knowledge about CS real contributions and a preference for data collected by scientists. Besides, academic career paths still rely on publication records in high-ranking academic journals, while the immense time and resources invested in building relationships and co-creation processes with citizens and other actors are undervalued. In order to boost a greater impact and recognition of CS as a scientific field, CS should be recognised as a research method in itself and not only as outreach to engage citizens. New incentives, reward mechanisms and societal engagement considered as an assessment criterion for academic promotion and funding calls need to also be established to encourage scientists to integrate citizens in their research, which entails a need for institutional changes in research funding and performing organisations.

From the policy side, the list of policy challenges presented in the Challenge Paper are the following:

- Engaging policymakers in the project. Think about which governance level your project may be most interested in depending on your project's scope (this will depend on the legislative governance level of the topic; e.g. in Spain health issues are legislated at the regional level).

- Think about ways of integrating citizen-generated data in official databases.
- Plan to produce policy documents resulting from the project results.
- Design ways of measuring and demonstrating your project's policy impacts.

The CS ecosystem has already identified the benefits of this field to inform evidence-based policies aligned with society and has highlighted them to policymakers at local, regional, national, European and international levels. Indeed, in recent years policymakers have started to support these types of initiatives. For instance, the EC has included CS into its Open Science Agenda and several environmental policies, and it has funded CS through H2020 and now through Horizon Europe[32]. It is worth noting that some EU MS have already developed CS strategies to support national practices, including some MS present in this MLE (for example, Austria, Germany and Spain), since CS is also a key element to tackle local and regional societal challenges. Nonetheless, the overall benefits and the potential of CS remain largely unknown for most policymakers at all governance levels.

2.5.1 Impact assessment in action: the ACTION impact framework

Since impact assessment is one of the main challenges for CS projects, the impact framework[33] developed within the H2020 funded ACTION Project (Grant Agreement No.: 824603) was presented during Topic 2 sessions by Dr. Antonella Passani from T6 Ecosystems. The ACTION impact assessment methodology considers scientific, social, economic and political impacts; it links CS impacts to EU Sustainable Development Goals (SDGs) and also considers the potential contributions to MORRI indicators. Its aim is to support the ACTION consortium, but also CS managers and researchers working on the benefits of CS, by providing a multi-dimensional, flexible and adaptable framework to be used in their work which is easily replicable. It is complementary with the data gathering instruments and guidelines[34] to be used in the actual application of the methodology.

[32] For further information see European Commission, Directorate-General for Research and Innovation, Haklay, M., Mutual learning exercise on citizen science initiatives: policy and practice. First topic report, Introduction and overview of citizen science: Horizon Europe policy support facility, 2022, https://data.europa.eu/doi/10.2777/29886

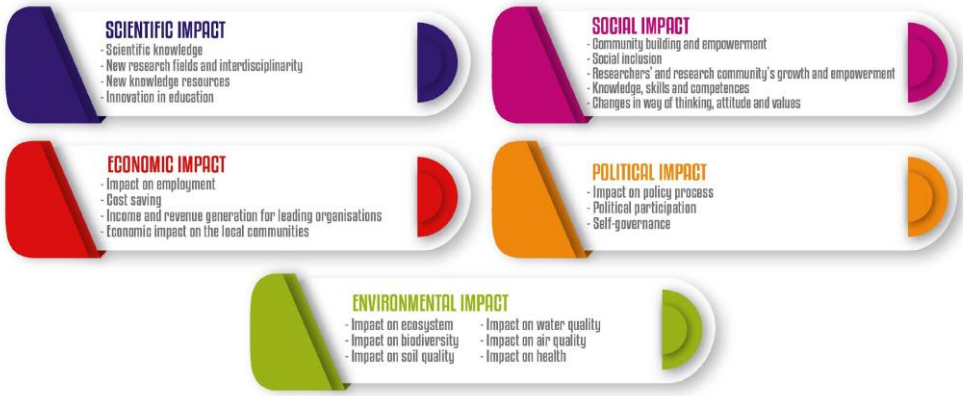
[33] Passani, A., Janssen, A., Hölscher, K (2021). Impact assessment framework. DOI 10.5281/zenodo.3968459

[34] Passani, A., Janssen, A., Hölscher, K (2020). ACTION impact assessment_Data gathering instruments and guidelines. https://zenodo.org/record/3968460#.YnEap9pByUm

Box 1 ACTION Impact framework

The ACTION impact framework was presented during the session by Dr. Antonella Passani. The main characteristics of the ACTION impact framework can be summarised as follows:

- It is modular: Each CS project can select the areas of impact that are of interest and the impact assessment is done only on those areas of impact.
- It is flexible: Ideally, each CS project should run an Ex-ante and Ex-post impact assessment in order to better monitor the changes between the situation "before" the project start and its conclusion.
- It is fully operationalized: Each impact dimension can be operationalized with indicators and variables.
- The ACTION impact assessment canvas consists of the following dimensions:



Source: Image retrieved from https://actionproject.eu/toolkit/

2.5.2 Highlighted projects with high demonstrated impacts: The cases of Teatime4science and D-NOSES

After presenting the ACTION impact framework as a useful tool to be used for impact assessment in CS projects, two highlighted projects were introduced as examples of achieved impacts. The first one was the Teatime4science project from Umea University, presented by Dr. Judith Sarneel as a successful example of a project that achieved a high level of participation through activities with

schools and other engagement strategies (see Table 1 for more details, as the success project selected by Sweden; more than 26,000 participants were involved in 2019). As for the scientific impact, the publication of the methodology already has around 200 citations. However, the policy, environmental, social and economic impacts of the project are still dispersed, although it managed to make the view on research and soils more positive.

Rosa Arias then presented the achievements of the H2020 D-NOSES Project (Grant Agreement No 789315), especially in relation to the policy impact. The project ran between 2018 and 2021 and followed a methodology based on CS to monitor odour pollution in affected communities, the second cause of environmental complaints after noise at a global level which is under-regulated. In most European countries there are no specific regulations to protect affected citizens suffering from odour pollution, and when they exist, they are heterogeneous as a common European framework is missing. To tackle this complex landscape, D-NOSES developed a multi-level governance model to inform evidence-based policies at different levels and advocate for the introduction of odour pollution in the policy agendas. As well as the scientific impact, with more than 20 scientific publications associated to the project, it produced different policy documents, most notably the Green Paper on odour pollution and the Strategic Roadmap for Governance, which were presented at the project final conference and at an event in the European Parliament entitled Revisiting Odour Pollution in Europe which was held in October 2021 and was hosted by MEP Maria Spyraki. During the event, a round table was organised with the participation of key members of DG ENV from the European Commission, from the Committee of the Regions, the Joint Research Centre, and quadruple helix stakeholders involved in the project, which expressed the need of recognising ambient odours as pollutants and to define a common European regulatory framework. As a result, Ms. Marieke Schouten, Rapporteur of the Committee of the Regions (CoR) opinion on the EU Action Plan: 'Towards Zero Pollution for Air, Water and Soil', requested to insert an amendment linked to odour pollution in the draft opinion of the Action Plan, which was adopted unanimously at its Plenary Session on 27 January 2022. At point 45 of the opinion, a paragraph was included on the issue of odour pollution, and the event is mentioned on the Opinion Factsheet of the Action Plan among the key consultations that allowed for the creation of the CoR opinion:

"*Points out that additional efforts are needed to reduce the levels of odour pollution and sees the Industrial Emissions Directive (IED) as the main tool to combat odour pollution since it covers all forms of emissions. The CoR underlines the importance of citizen science and public participation for tackling odour pollution challenges. A multi-level approach including different inputs of various stakeholders can empower citizens to participate in decisions made about their environment and can support policy-makers and odour emitting activities to make informed decisions and better manage the issue of odour pollution*;".

This can be considered as a big achievement in terms of policy impact of the D-NOSES project, which was materialised almost 4 years after it started. More details on the multi-level governance model developed within D-NOSES, which can be replicable and applied to any other social or environmental challenges, can be found in Box 2.

After presenting both projects, a discussion was opened and participants shared their opinions on stakeholder engagement and their motivations, especially in relation to policy makers. Interventions included how the COVID-19 pandemic has changed the world, with policymakers prioritising issues related to the pandemic, and thus totally changing their priorities and policy agendas. In times of global crisis, it is more important than ever to think about the impact that CS projects can have at the different governance levels - from local, regional, national and European, to even global level. It is important to design *ad hoc* advocacy plans and actions towards the achievement of those expected impacts from the very beginning of a CS project. Gaining trust with the targeted policymakers is key. This usually requires time, patience, and the use of the right channels and messages. Alignment with already existing policy agendas and timings is also crucial[35]. In other cases, though, the impact of the pandemic has been positive in terms of impact, as highlighted earlier[30]. For example, the project selected by Slovenia showed that COVID-19 also led to the implementation of specific CS projects that added value: CS as a research method which gained the attention of policymakers.

An agreement was reached by the MLE participants on how important it is to introduce an impact framework from day 1, in the design phase of CS projects, which is supported by experts. CS projects may need training in several aspects since interdisciplinarity is key and one person cannot know everything. Thus, support mechanisms and MLEs are crucial to guarantee a successful implementation.

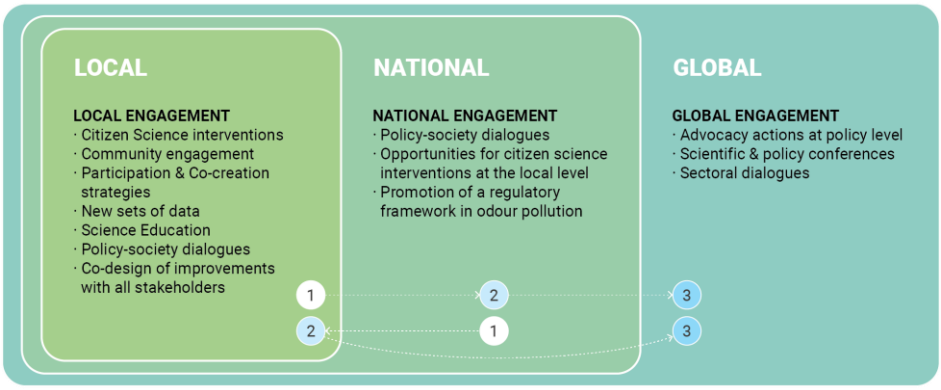
[35] Reflections on how excellent science communication can help CS projects achieve their policy impacts can be found in the NEWSERA Policy brief addressed to policy makers.

Box 2 D-NOSES Multi-level governance model that led to Policy Impact

The D-NOSES project (Distributed Network for Odour Sensing Empowerment and Sustainability) developed a citizen science methodology to monitor odour pollution and to co-create local improvements to reduce the impact of odour pollution in 10 pilot sites in Europe (Spain, Greece, Portugal (2), Italy, UK, Germany and Bulgaria), Chile and Uganda. Through the App OdourCollect the project managed to put odour pollution on the map, while the International Odour Observatory raised awareness and provided access to information on odour pollution in order to fill the gap in accessing environmental information in relation to odour issues, contributing to giving compliance to Principle 10 of Rio Declaration from UNEP.

To tackle the complexity of regulating ambient odours, D-NOSES developed a multi-level governance model that has been widely applied at the local, national, European and international levels to involve key stakeholders in the public debate - with the aim of introducing odour pollution in policy agendas, of advocating for a common European regulatory framework and for the recognition of ambient odours as pollutants. D-NOSES partners participated in 16 policymaking-oriented events with a total of 1,397 participants. The advocacy work and corresponding policy results are gathered in the Green Paper and the Strategic Roadmap for Governance in odour pollution, two documents that serve as call-to-action documents, both for European, national, regional and local decision makers.

Multi-level engagement strategies for a multi-level governance model in odour pollution



[36]

[36] Image retrieved from the Green Paper on Odour Pollution (D-NOSES project)

2.6. Challenges for Sustainability

This section corresponds to **Variable 5: Fostering Sustainability**, which is linked to the achieved impacts in a high degree, and was revised according to the list of challenges presented in the Challenge Paper:

Challenges for Sustainability

- Lack of resources to maintain technological tools (e.g. CS apps or web platforms).
- Maintaining engagement (overcoming participation fatigue).
- Financial sustainability to ensure a long-term perspective and long-term data sets.
- Upscaling and replicability mechanisms to cover wider geographical areas or other research fields.
- Lack of spaces to learn how to do CS, which can be especially relevant to younger generations.

The sustainability of CS projects once the funding ends represents one of the most important challenges. It also poses some ethical issues, such as maintaining and giving feedback of the actions to the already established communities of citizens that have contributed to the project. In general, to realise its full potential, CS needs to address its sustainability transitions through:

1) defining exploitation plans and new business models;

2) finding additional resources (either public or private) beyond grant fundings;

3) considering how to ensure the legacy of CS projects; and

4) considering how to scale up or spread[37] the activities, outcomes and impacts of CS initiatives, at the geographical level, but also by replicating the methodology in other communities, or to tackle similar societal challenges.

Mainstreaming CS and building new investments to sustain projects may be a natural way to reinforce CS sustainability and its impacts in our societies. The questions below were asked to participating countries in order to understand the sustainability plan and expected impacts of each CS project:

- Does the project have an impact evaluation framework?

[37] Maccani, G., Goossensen, M., Righi, V., Creus, J. and Balestrini, M., Scaling up Citizen Science, Publications Office of the European Union, Luxembourg, 2020, ISBN 978-92-76-25157-6, doi:10.2760/00926, JRC122219.

- Is the impact of the project regularly measured at different levels? If so, how often?
- Have any scientific results been published and/or presented in scientific conferences?
- Is there any type of recognition for doing CS at a professional level?
- Do citizens receive any type of recognition for their participation?
- Is the data produced integrated in any official database?
- Was any policy document produced from the project results?
- Were policy makers engaged in the project? At which governance level?
- Is there an exploitation plan for the project?
- Is the project replicable at a different scale or different geography?

The results were showcased in the form of traffic lights as follows: The traffic lights illustrate the yes/no answer of participants corresponding to each question and country.

Figure 5: Traffic light illustration of the projects' impact and its sustainability strategies corresponding to each project: 1) Existence of an impact evaluation framework; 2) Impact being measured; 3) Scientific results published; 4) Academic recognition; 5) Citizen recognition; 6) Data integrated in official databases; 7) Policy documents produced; 8) Policy makers engaged; 9) Existence of an exploitation plan; 10) Project replicability.

Approximately half of the projects have an impact evaluation framework that is measured continuously, yearly or at the end of the project, through questionnaires (e.g. surveys with citizens or schools) or web page analytics. In a similar way, the impact related to the participation in the academic sphere (through publication of papers or assistance to conferences) is generally within the projects at different levels; some have published peer-reviewed papers, book chapters and attended to different conferences, although one project affirmed that it did not have time for that (Topotheque).

Public or academic recognition of the CS researchers, through awards to members of the project or through support from public institutions, is found in almost 70% of the projects, and in the cases that it has not occurred, the project leaders state that CS is not taken seriously in their scientific field. On the other hand, the recognition to participants for their participation is generally between

the projects and it is based on recognition signs (e.g. receiving a diploma, recognition through the project website), citation on papers, or invitation to project tasks or conferences to increase their sense of belonging.

In relation to the interaction and impact of CS projects with public institutions, only one of the projects (Spipoll) has integrated their databases with national public repositories, while another one is planning to integrate it in the future (Expedition Erdreich). Additionally, the French programme Spipoll is also producing a policy document and contributing to a national action plan, while another project will send a report based on citizen-generated data to the Environmental Ministry. Generally, the projects do not engage significantly with policy makers (2 out of 8), as only one project has contacted policy makers at municipal level and another one at national level.

Another important aspect is the long term sustainability of the projects. In that sense, when asked about the exploitation of the project, half of the projects responded that they had planned that aspect. In those responses, a common concern was the dependency on funding and the commitment of continuing the project implementation in the long term. Also, some projects have plans to further develop the tools and reach of the project through different improvements (app development, merging with other projects, etc.), which also depends on available funding. On the contrary, other projects have not defined an exploitation plan, as they consider that the work done by CS must not be monetised. Another interesting insight was that all the projects responded affirmatively to the aspirations of replicating their projects at different scales and in different countries. In fact, some of them had already been replicated in other neighbouring countries or municipalities, which shows the high replicability potential of CS initiatives.

2.7. Final reflections and main conclusions

After finishing this part of the workshop on the implementation of challenges faced by CS initiatives, based on the 11 successful examples of CS projects selected by the participating countries, an open discussion followed, where relevant aspects were highlighted and are summarised below.

There is a common feeling of a **lack of urgency in fostering the mainstreaming of CS practices across Europe**, even though the potential benefits of CS to align science with society have already been widely recognized at different policy levels, including the EC Open Science policies. Thus, this common feeling of a lack of urgency in fostering the mainstreaming of CS practices across Europe, which takes into account citizens' concerns, while fostering critical thinking, increasing transparency and trust and fighting misinformation, and produces quality data of scientific value to tackle societal challenges and inform evidence-based policies, was highlighted by participants.

In this regard, CS as a field requires more maturity to further demonstrate its benefits and achieved impacts, which at the same time requires an increased institutional support at different levels. It is not realistic to request CS practitioners to become multidisciplinary experts, implement and face on their own all the above mentioned challenges related to each of the variables analysed without further support and without academic or public recognition. By promoting and having different and diverse career paths in academia, it may be possible to achieve improved, wider and sustainable CS practices and overcome the different challenges presented under this Topic. Participants agreed that an increased support for researchers from public institutions is needed in order for them not to feel that they "need to do - and know how to do - everything" by themselves. As individual researchers cannot have expertise in all the required fields to successfully implement a CS project (including their scientific field, social sciences and humanities to be able to engage citizens, IT skills for data collection and analysis, science communication skills towards quadruple helix stakeholders, impact measurement capabilities and strategic views to guarantee sustainability), promoting interdisciplinarity work and strengthening CS research as an emergent, powerful and highly replicable scientific field will be extremely beneficial. In this way, it will also be possible to achieve greater diversification of CS topics, research questions, scopes and scientific domains.

The next chapter "The way to go: National Initiatives to promote citizen science" presents the main challenges related to national and European schemes to promote CS, together with the existing CS national platforms and funding opportunities existing in the 11 countries participating in the MLE.

3. The Way To Go: National Initiatives To Promote Citizen Science

National strategies to promote CS is one of the best ways of reinforcing the practice and mainstreaming of CS, building on the investments made to date, from Horizon 2020 and Horizon Europe, to more local or regional efforts. The debate on this topic departed from the challenges presented in the Challenge Paper which are:

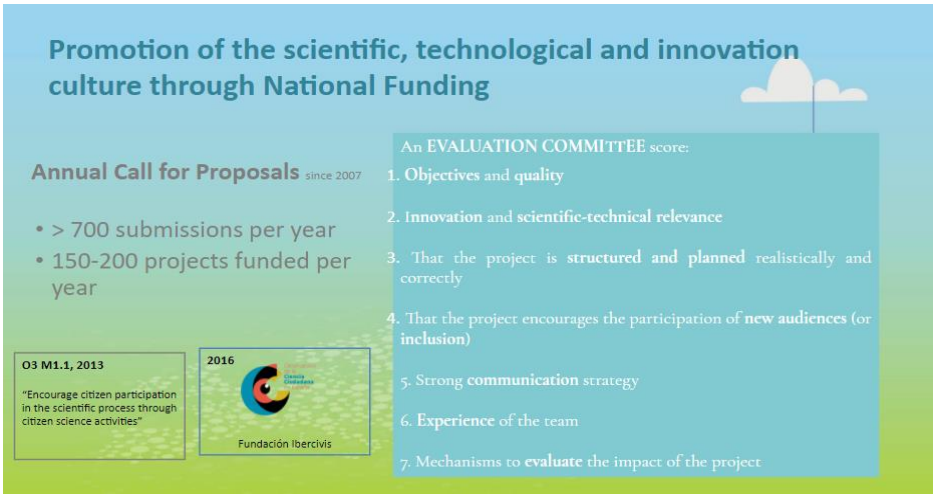
Challenges for National/European Schemes

- Different levels of maturity of CS practices across countries.
- Limited transfer of knowledge across countries: limits replicability, increases the required efforts, limits maturity of results.
- Necessity of building a strong European network and supporting mutual learning, role modelling, and best practices.
- Different support mechanisms and funding schemes (when existing) in the different countries.

Some of these challenges will be widely tackled by the current work under this MLE promoted by the Policy Support Facility of the EC, such as the limited transfer of knowledge between countries, or the differences between levels of maturity and support strategies within the 11 participating countries. In addition, the work under the EU-Citizen.Science project - and the new ECS project to come, funded under Horizon Europe - has significantly contributed to the creation of a strong European CS network, to support mutual learning and share knowledge and best practices among participants, which will continue in the following years, contributing to the strengthening of its practice.

In addition, some countries have a long tradition in supporting CS initiatives. This is the case in Spain, a country which is not participating in the MLE, and that is why it was invited to present its experience during the first day of the Topic 2 workshop series. Cecilia Cabello from the Spanish Foundation for Science & Technology (FECYT) presented the Spanish national funding scheme to support CS practices. The Spanish case is particularly interesting since FECYT is the main national organisation that catalyses the relationship between science and society, promoting Spanish scientific culture and fostering the transfer of knowledge through outreach, education, training, information and advice, and have been funding first science communication and later specific CS initiatives in the last years (see Box 3). FECYT also collaborates with other agents and actors of the science, technology and innovation system to internationalise Spanish science, providing support in the management of scientific information and open science. It also works in the science diplomacy field to connect science with policies and manages the brand-new science office to inform the Spanish Congress.

Box 3 Strategy to support CS initiatives in Spain, led by FECYT



Since 2007, FECYT has launched annual calls for proposals to promote the scientific, technological and innovation culture, with more than 700 submissions per year and a total of 150-200 projects funded annually. After defining an Action Plan for the strengthening, development and consolidation of CS in Spain in 2017, the first CS call was launched in 2018, with a funding scheme of €300,000. Since then, the organisation has funded CS projects with over €960,000, increasing by 21% the total number of submissions and by 25% the funding scheme (€). The call supports both new and ongoing projects.

In addition, FECYT also funds the Spanish Observatory of Citizen Science since 2016, as a platform to map current initiatives and promote networking and mutual learning between practitioners and institutions.

In the longer term, the Spanish Strategy for Science, Technology and Innovation 2021-2027, launched in September 2020, promotes "The social and economic responsibility of R&D&I through the incorporation of citizen science and the application of co-creation and open access policies, as well as the alignment of R&D&I with social values, needs and expectations". Finally, under the Science, Technology and Innovation reform from February 2022, the following paragraph will be introduced into Law 14/2011 on Science, Technology and Innovation, Article 38: "Promote citizen participation in the scientific and technical process through, among other mechanisms, the definition of research agendas, observation, data collection and processing, impact assessment in the selection of projects and monitoring of results, and other citizen participation processes."

After the presentation of the successful Spanish strategy to support CS initiatives, there was an open discussion where the participating countries had the opportunity to present the initiatives already existing in their respective

countries, following their answers to a pre-questionnaire[38]. The following table gathers the examples of CS networks and centres of expertise provided by the participating countries in the MLE, where information, training, examples and general national support for CS practitioners can be found. Another highlighted initiative is the Citizen Science Network in Austria[39], which is the only CS network that nowadays has permanent long-term basic funding.

Table 2: CS national platforms and networks currently existing in the countries participating in the MLE.

Country	**Network**	**Webpage**
Austria	Centre for Citizen Science	https://zentrumfuercitizenscience.at/en/
	The Citizen Science Network Austria	https://www.citizen-science.at/en/network
Belgium (Flanders)	Scivil.be	https://www.scivil.be/over-scivil.
	Iedereenwetenschapper	www.iedereenwetenschapper.be
Belgium (Wallonia)	Natagora	https://www.natagora.be/
Belgium (Brussels)	Natuurpunt	https://www.natuurpunt.be/pagina/over-natuurpunt
Germany	Bürger schaffen Wissen	https://www.buergerschaffenwissen.de
Portugal	Rede Ciência Cidadã	https://www.cienciacidada.pt/
Italy	Italian SNPA Citizen Science Group	https://www.snpambiente.it/category/temi/comunicazione-educazione-partecipazione/citizen-science/
Norway	Norwegian Network for Citizen Science	https://www.globe.gov/web/norway-citizen-science/home
Sweden	Medbordgarforskning	https://medborgarforskning.se/

Among the 11 participating countries, 4 did not have a specific national observatory or network aggregating CS initiatives (FR, HU, RO and SI). The remaining countries have centres and networks that have been created relatively recently, e.g. Citizen Science Network Austria was created in 2015, the German Bürger schaffen Wissen in 2014 and the Norwegian Network for Citizen Science

[38] Link to the questionnaire https://docs.google.com/forms/d/e/1FAIpQLSd8Riun9D9mFwyVfdfkxoxZXIKzEHGyeBqdpvOXmdyS-qq3QQ/viewform

[39] For further information: https://www.citizen-science.at/en/

in 2021. In Belgium, initiatives exist at regional level: Scivil was created in 2018 for the Flanders region, while Natagora is present in Wallonia and Natuurpunt in Brussels.

Participating countries were also asked about the current funding opportunities for CS in their respective countries. The importance to start and continue funding dedicated CS actions at the national level to pursue efforts in strengthening networks, reinforcing training and capacity building efforts, helping overcome institutional barriers, pushing recognition, facilitating data infrastructures, organising joint events, contributing to demonstrate CS impacts, and facilitating the coordination and communication among projects in Europe and its Member States were highlighted by participants. Together with the support from the EC, national actions to support CS provide a unique opportunity to test and refine mechanisms to improve the practice of CS. While several initiatives can be set in place at national level to support CS practices, adequate **infrastructures (as Observatories or Platforms) to build-up networks of CS initiatives** have become increasingly important in providing support to the projects and its participants, together with national or regional funding opportunities. The following figure summarises the current support to CS in the 11 participating countries. The first traffic light shows the current state of national observatories in the 11 participating countries, while the second traffic light depicts the funding opportunities present in each country.

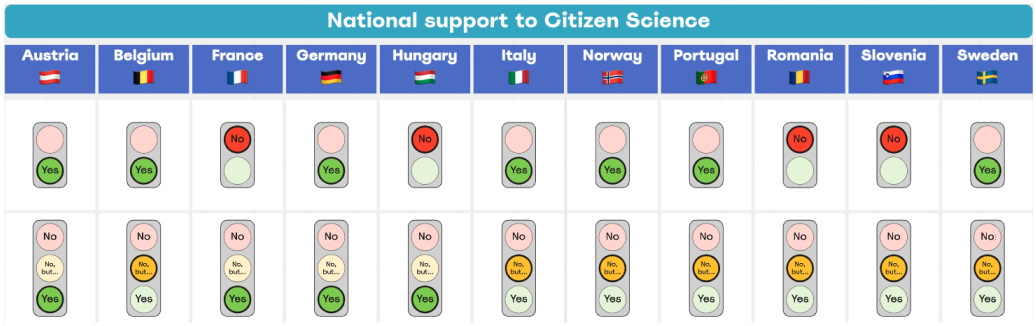


Figure 6: Current state of national observatories and funding opportunities that support CS practices in the 11 countries. The first row corresponds to the existence of national observatories or networks, while the second refers to current national funding opportunities, either specific to CS initiatives (marked as "yes") or general funding calls where CS practices can be embedded (yellow colour; details can be found in Table 3).

Regarding the funding opportunities, approximately two thirds of the countries do not have specific calls for CS, meaning that they need to compete with other types of research projects - usually open science or science communication initiatives - and/or reach alternative sources for securing funding. Countries that present concrete national funding for CS projects are Austria, France, Germany and Hungary (in green light), and Belgium has regional permanent CS calls.

CS infrastructures make CS projects more visible and accessible for those stakeholders that want to get engaged and are very useful to support newcomers

and ongoing projects. Similar initiatives can get in contact to learn from each other[40], build capacity, reuse existing resources and maximise their outcomes. National infrastructures and networks can also be used to provide local, regional and national authorities with necessary information on key and emerging topics affecting public agendas. They are also relevant for scientists to access new sets of data and to conduct research, or for CS practitioners wishing to replicate an initiative in another territory. In most cases, however, the greatest challenge for Observatories or Platforms and Networks is to obtain permanent funding. It could be of benefit for all to establish together with public authorities strategies to promote national CS observatories/platforms and networks that take into account:

1. technical components (quality criteria to maintain high standards for CS research methods),
2. communication strategies,
3. openness and flexibility for a better adaptation to emerging needs,
4. more collaborative and interactive types of platforms,
5. shared resources,
6. networking capabilities,
7. promotion of joint events, and
8. contents addressed to citizens to boost their participation in CS activities.

All these aspects will certainly lead to greater mutual learning and resources sharing in the long run, while contributing to the mainstreaming of CS.

Some insights coming from the comparison of the national funding opportunities provided by the 11 participating countries are:

- Italy and Slovenia did not identify any national funding opportunities, while Austria identified four different opportunities.
- The funding ranges from €20,000 to €600,000 per project depending on the country and the duration of the project.

[40] As an example, there is a working group specifically created to coordinate the work across Germany, Austria and Switzerland (the three big German speaking countries in Europe): https://www.citizen-science.at/en/network/working-groups/wg-d-a-ch, which exchanges information across national borders.

- The duration of the funding ranges from 1 to 4 years, with a common duration of 2-3 years.

- Almost all the funding opportunities are organised at national level, but it is interesting to see regional funding in Austria and Belgium.

- Eligibility and evaluation criteria in the different funding sytems is typically based on impact, excellence and quality, but also includes other aspects such as relevance of the research, degree of transparency (e.g. in Austria's Sparkling Science 2.0 programme, the archive and publication of teaching and learning materials developed during the project are included), or satisfaction of the projects' participants.

- Other dimensions that appear as eligibility and evaluation criteria are inclusivity, ethics and gender.

More detailed information about the different funding opportunities in the CS MLE countries can be found in the following table:

Table 3: CS national funding opportunities detailed by MLE participants in the countries

Country	Name of the funding	Specific to CS	Funding institution	Range of funding
Austria	Top Citizen Science	Yes	Austrian Science Fund (FWF)	€50,000/project
	Sparkling Science 2.0	Yes	Austria's Agency for Education and Internationalisation (OeAD)	€350,000/project (€9,5M total funding)
	RTI Projects: Basic Research	No	Gesellschaft für Forschungsförderung Niederösterreich m.b.H (GFF NÖ)	Max €100,000/project
	Public & Patient Involvement and Engagement in Research (PPIE)	No	Ludwig Boltzmann Gesellschaft Open Innovation in Science Centre (LBG OIS Centre)	€20,000-60,000/ project
Belgium	BRAIN-be 2.0 (Belgian Research Action through Interdisciplinary Networks)	No	Belgian Science Policy BELSPO	Total budget of €117M
France	Agence Nationale de la Recherche	No	Agence Nationale de la Recherche	*Still not available*
Germany[41]	Zweite Richtlinie zur Förderung von bürgerwissenschaftlichen Vorhaben	Yes	Federal Ministry of Education and Research (BMBF)	€9M for 15 projects
Hungary	The Hungarian Scientific Research Fund (OTKA): *Mecenatúra*	Yes	The National Research, Development and Innovation Office	Total budget of €1,800,000
Norway	The Research Council of Norway	No	The Research Council of Norway (RCN)	*Still not available*
Portugal	Projetos de I&D (R&D Projects)	No	Foundation for Science and Technology (FCT)	*Still not available*

[41] Additionally, in Germany Citizen Science projects can also be funded as part of the annual funding guidelines for the Science Years of the BMBF.

Romania	Research projects to stimulate young independent teams, subprogramme 1.1 - Human Resources within the National Research-Development and Innovation Plan (2015 – 2020).	No	UEFISCDI (Executive Agency for Higher Education, Research, Development and Innovation Funding)	*Still not available*
Sweden	Kommunikationsutlysning	No	Swedish Research Council for Sustainable Development (FORMAS)	*Still not available*

4. Recommendations

CS initiatives are one of the few fields that help to make sure that scientific agendas are well aligned with societal interests, challenges and needs. They also encourage all citizens, including the so-called vulnerable communities, to take a stake in the world around them. As a consequence, CS helps to empower citizens who can play an important role in producing valid evidence to inform scientific-based decisions and public policies. It is therefore necessary to continue funding dedicated CS actions to pursue efforts in supporting new or ongoing projects, strengthening networks, boosting communication among projects, and supporting newcomers to this field. While **general calls may be one avenue to approach the support of CS** (e.g. by including public engagement, open data, co-creation or the establishment of transdisciplinary teams in the evaluation criteria), a more effective pathway is to explicitly **mention CS in specific calls**. In doing so, it would be easier to assess how criteria may differ between CS specific funding calls and the more general calls. Some general recommendations for funders running general or specific CS calls include:

- Adequate infrastructures (as Observatories or Platforms) to build-up networks of CS initiatives have become increasingly important in providing support to the projects and its participants, both nationally and in Europe.

- Resources cannot be underestimated. Like any other R&I activity, engaging citizens in research requires time and appropriate knowledge. The deeper the engagement level requested and the wider the inclusivity and diversity sought, the higher the cost.

- Make it simple and trustworthy for practitioners and applicants. If needed, webinars to explain step-by-step how to apply, or to provide specific guidance for finance departments on funds and calls, shall be organised.

- If using general calls, highlight your interest in using CS methods, or include other aspects such as public engagement, co-creation, gender or diversity under the evaluation criteria.

- Think of the geographical scope that you want to achieve, if any. This also relates to the number of citizens to engage and/or to the size of the data sets to be collected - and thus to the cost of engagement.

- Consider how non-traditional actors in the R&I space (e.g. NGOs, local community organisations, faith-based organisations, etc.) can apply and access the funding.

- Think of different mechanisms of financial support to promote the sustainability of CS projects once they have ended. For example, prizes or cascading grant mechanisms can help. Cascading grants are small

amounts (in the form of grants or prizes) organised in order to reach grassroots initiatives at the national, regional or even local levels. They can help to engage local communities, civil society organisations and other non-traditional or hard-to-reach groups of stakeholders in science.

- Think of other ways of supporting the community, for example, by organising national events or thematic workshops, by promoting mutual learning, capacity building, guidelines/information platforms and training sessions, by supporting common data infrastructures or repositories, or by contributing to the communication and dissemination of the project results.

- Incubator models are another great example of promoting CS practice since it nurtures projects in different phases of development through coaching, training, and shared learning.

- Take into account the implementation challenges stated above to define the scope of the call (and thus the related funding).

- Think of the main objectives and impacts that you want to achieve with the call in the medium to long term and prioritise accordingly.

- Define evaluation criteria that are relevant to the implementation of CS practices, taking into account their unique characteristics.

- Try to understand the institutional barriers faced by practitioners to implement CS activities and support relevant mitigation strategies, e.g. by incentivising and rewarding citizen participation and science communication in academic curricula, among other aspects.

Finally, participants were asked to vote on the **most promising national support mechanisms and strategies to strengthen CS,** to draw the lessons learnt from the MLE undertaken with the 11 countries during Topic 2. The resulting ranking is as follows:

1. Work on recognition and institutional barriers

2. Facilitate training and capacity building

3. Launch specific CS calls

4. Include specific evaluation criteria in general calls

5. Build common repositories, observatories or platforms

6. Launch calls for replication/upscaling of ongoing projects

7. Increase or enrich new or existing networks

8. Use cascade funding schemes

9. Promote common data infrastructures

10. Support CS practices through incubator models

It was agreed among country representatives that CS needs more specific funding calls that are well dimensioned in terms of the resources needed. For instance, within the Horizon Europe framework, where public engagement and co-creation is meant to be a cross-cutting issue among Clusters and Missions, evaluators not familiarised with CS practices may not be fully aware of the efforts in terms of personnel, resources and time required to have an effective involvement of citizens in science. The more societal impact is sought, the more the answer becomes CS, in any scientific field of research.

In the same line, Romania explained that even though CS is at an early stage of development in the country, the national Research & Innovation and Open Science strategies are currently under development, where CS will be included. Thus, the country will support CS for the next generation of projects.

With regard to sustainability, representatives mentioned that this is usually a general challenge in science. To fund existing projects is a challenging endeavour, which may require other forms of evaluation criteria that would relate more to cascade funding schemes or career pathways where researchers would better value the societal impact rather than the number of publications in scientific journals.

On a different level, participants argued that special differentiation would be required regarding, for instance, citizen engagement in ordinary research projects which do not implicitly need to develop a CS approach. In this regard, CS funding calls targeting specific societal groups would be of high importance. The engagement level sought by each CS approach may also influence the logic and strategies behind funding schemes.

Another key element in CS is the data management plan. As citizens are engaged in research, data management in relation to personal data protection and ethics is very important, and should also be considered in the call definition and evaluation criteria.

Finally, Slovenia highlighted the importance of involving underrepresented citizens in science, even though it is a challenging endeavour in every scientific field. As volunteering participation does not always work, it may require attracting them in a different way if we want all voices to be heard. In the end, the deeper a project wants to engage with citizens, the more effort and resources it will need. Hungary complemented the intervention by mentioning the importance of local

communities in scientific research and the need to have a space for mutual cooperation and learning.

Overall, it is expected that CS will become more relevant under Horizon Europe, which promotes CS as part of open science, and the participation of different stakeholders in co-design and co-creation processes. Horizon Europe will reinforce the relationship between science and civil society by their direct involvement in the process of "doing" research[42]. Moreover, the impact pathway number 6, called "strengthening the uptake of innovation in society", starts with initiatives in which members of the public and end-users co-design R&I content, and one section under "reforming and enhancing the European R&I system" highlights CS[43]. Therefore, in the EU framework, a high number of CS projects can be expected to bloom in the different missions[44], clusters and programmes.

From the overall discussions and all the information gathered, the huge potential of CS to open up science to society, align research agendas considering citizens' needs, produce relevant data sets to tackle societal challenges and inform evidence-based policies, increase science literacy and education, promote critical thinking and fight misinformation, and to increase trust in science, transparency and social inclusion was widely recognised by the 11 participating countries, and the need for further support (both for new and ongoing initiatives) was evidenced. It is the funding agencies, either at national, regional or European levels, who have the responsibility of continuing to support these important initiatives to gather new scientific evidence aligned with societal needs in times of crisis, in the form of funding, creation of networks, building capacity and training, and increasing recognition at institutional level. At the same time, CS practitioners need to demonstrate the virtues of this emerging scientific field to increase trust and recognition, and work together to collectively overcome the challenges and barriers highlighted in this report to produce and demonstrate the excellence of CS initiatives, its impacts and their benefits for science and society.

[42] European Commission https://medies.net/wp-content/uploads/2020/07/CitizensScience_Factsheet_Final.pdf.
[43] "Paving the pathways to impact in Horizon Europe", Angelica Marino, European Commission DG Research & Innovation.
[44] https://op.europa.eu/en/publication-detail/-/publication/5b2811d1-16be-11e8-9253-01aa75ed71a1

5. Concluding Remarks and Next Steps

As highlighted in the first Topic report[45], the purpose of this MLE is to facilitate an exchange of information, experience, and to identify good practices and policies to scale-up CS at different territorial levels. The MLE is structured in five rounds of meetings on specific topics that have been pre-identified by the countries participating, and were agreed upon by all during the first meeting, which started with an "Introduction and Overview of CS".

During the working sessions of Topic 2 "Ensuring Good Practices and Impacts", on the 7th and 14th of March 2022, participating country representatives analysed national initiatives supporting CS across Europe. The practices of 11 projects selected as successful examples were examined against selected variables to understand the different alternatives to implement CS projects and learn from their experiences, considering that there are no correct nor perfect ways of implementing a CS project, and that one solution may not fit all. Good practices and lessons learnt were extracted in aspects such as participation, engagement, inclusivity and diversity; data quality and openness; science communication; demonstrating impacts, and fostering sustainability, and the conclusions are presented in this report.

In the next topic meetings, a deeper analysis will be undertaken on some of those aspects. Concretely, the remaining topics will deal with:

- Topic 3: Maximising the relevance and excellence of citizen science
- Topic 4: Enabling environments and sustaining citizen science
- Topic 5: Scaling up citizen science

The MLE event will conclude with a final event in December 2022. Additionally, a dissemination event will be organised in Brussels as an opportunity to present the results of the MLE to the wider public (expected in early 2023).

[45] European Commission, Directorate-General for Research and Innovation, Haklay, M., *Mutual learning exercise on citizen science initiatives: policy and practice. First topic report, Introduction and overview of citizen science: Horizon Europe policy support facility*, 2022, https://data.europa.eu/doi/10.2777/29886

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This Topic Report provides a summary on the Mutual Learning Exercise on Good Practices on Citizen Science and their Impact. This document starts by presenting the examples of successful CS national projects chosen by the 11 countries participating in the MLE, and the variables against which the projects were analysed. Chapter 2 summarises the results related to challenges & mitigation strategies with the implementation of CS projects. Chapter 3 analyses the examples of CS networks and centres of expertise and presents the current state of national funding opportunities that were provided by the 11 participating countries in the MLE. Chapter 4 provides recommendations which cover a range of potential actions targeting different aspects discussed during the workshop sessions to better implement and especially support CS initiatives and projects and overcome the detected barriers. The document concludes with Chapter 5 which briefly explains the next MLE topic sessions.

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