ScienceUs

D2.2

WP2

CHALLENGES AND OPPORTUNITIES FOR CITIZEN SCIENCE UNDER THE NEW ERA FRAMEWORK AND EU MISSION “ADAPTATION TO CLIMATE CHANGE”

Report By :
MFN

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DELIVERABLE 2.2

CHALLENGES AND OPPORTUNITIES FOR CITIZEN SCIENCE UNDER THE NEW ERA FRAMEWORK AND EU MISSION "ADAPTATION TO CLIMATE CHANGE"

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Executive Summary

Deliverable 2.2 Challenges and Opportunities for Citizen Science under the new era framework and EU Mission "Adaptation to Climate Change", **offers a comprehensive, evidence-based analysis of the potential contributions in which citizen science initiatives can actively contribute to enhancing climate resilience in Europe.** It explores how these participatory, community-driven efforts can increase climate resilience by fostering localized stakeholder engagement, improving the granularity and coverage of data collection and supporting evidence-based decision-making at various levels of governance. In addition to highlighting the potential, the deliverable also identifies and critically examines the key challenges currently constraining the scalability and effectiveness of citizen science in climate adaptation contexts. These include issues such as recruitment and maintaining engagement of volunteers, insufficient institutional support, concerns regarding data quality and validation, and the critical need for sustained funding. By addressing both the opportunities and structural obstacles, Deliverable 2.2 lays the groundwork for more effective collaboration between citizens, scientists, and policymakers in the collective pursuit of climate resilience across Europe. The findings presented in this deliverable are based on a triangulated approach, incorporating both qualitative and quantitative data collected through multiple channels. Two online surveys served as the primary data collection tools: one targeted EU-funded projects that are not currently using citizen science approaches, while the other focused on projects that are actively implementing citizen science in the context of climate change adaptation. To deepen and contextualize the insights gathered through the surveys, a series of semi-structured follow-up interviews were conducted with strategically selected participants. Additional input was obtained through structured feedback forms following the ScienceUs Upscale Academy Bootcamp in Berlin, which brought together 25 citizen science initiatives working on climate change adaptation across Europe. This mixed-method research design ensured a robust and multidimensional evidence base, capturing a wide range of experiences, perspectives, and practices.

This deliverable is part of Work Package 2 (WP2) of the ScienceUs project, whose aim it is to identify the barriers, challenges, and best practices that influence citizen science initiatives' scalability and long-term success, in alignment with the objectives of the New European Research Area (ERA) and EU missions. This deliverable contributes to the overarching goal of ScienceUs: establishing a Europe-wide network of interconnected citizen science projects aimed at maximizing the contribution of participatory research to the EU Mission Adaptation to Climate Change. Gaining a clearer understanding of the current challenges faced by citizen science initiatives is essential for identifying critical areas where targeted policy support and capacity-building measures are most needed. This awareness can help strengthen the sustainability, effectiveness, and long-term viability of citizen science contributions to climate adaptation frameworks. At the same time, shedding light on the opportunities within the sector

can catalyze increased stakeholder engagement, raise public and institutional awareness, and encourage broader, more inclusive participation in citizen science. By mapping both structural barriers and emerging potentials, this report aims to inform strategic actions designed to maximize the contributions of citizen science to climate change adaptation—ensuring these initiatives can play a more impactful and enduring role in building resilient communities and ecosystems across Europe.

Introduction

Climate change is one of the most pressing and complex challenges of our time, and its impacts are manifesting at an accelerating pace across diverse ecological and socio-economic systems. Europe is experiencing a rate of warming faster than any other continent (Copernicus Climate Change Service and World Meteorological Organization, 2025), intensifying the need for rapid, coordinated, and systemic action to build climate resilience at multiple governance levels. In response, the European Union has set an ambitious goal: to become climate-resilient by 2050. Achieving this objective requires the combined efforts of policymakers, scientists, and society at large, operating synergistically across sectors and disciplines.

One promising approach to bridging these domains is citizen science— representing an inclusive, participatory method of knowledge co-production that actively engages the public in scientific processes. By empowering individuals and communities to engage in data collection, environmental monitoring, and problem-solving, citizen science can play a vital role co-creating adaptation strategies that are both locally grounded and scientifically informed.

Despite its potential, citizen science remains underutilised in EU-funded climate adaptation efforts. Out of more than 230 ongoing Horizon Europe and EU Mission projects addressing climate change adaptation, only 29 have integrated a citizen science component. This pronounced gap highlights a wealth of untapped potential—one that this report seeks to explore and address.

The Task within WP2: aim and objectives

This deliverable primarily builds on the results of task T2.3, which sits within WP2, and was led by the Museum für Naturkunde (MfN). The aim of task T2.3 was to identify the key challenges and opportunities related to the implementation of citizen science within Horizon Europe and EU Mission projects active in the field of climate change adaptation.

WP2 is structured around four core objectives, each designed to enhance the integration and scalability of citizen science in climate adaptation research:

- perform a benchmark in citizen science practices based on the identification of areas for improvement and best practices with the aim of increasing the effectiveness and impact of citizen science.
- assess the interest of different research projects related to EU missions to use EU-wide citizen science campaigns

- identify relevant and representative examples, a meaningful number of them, citizen science campaigns in the context of research projects.
- obtain evidence and data to illustrate to the different actors of the quadruple helix the interest of a change of mindset through a citizen science approach in the new ERA.

The analysis of challenges and opportunities for citizen science in the context of the EU Mission "Adaptation to Climate Change" carried out within task T2.3 and presented in this deliverable contributes to this aim by providing important insights into how citizen science can help address existing gaps in the adaptation landscape, whilst also identifying challenges and barriers that need to be overcome to realize the full potential of citizen science in this field.

Findings from the different datasets compiled and analyzed in T2.3 demonstrate strong interest in citizen science on the part of EU-funded research projects working on climate change adaptation, provide lighthouse examples of projects that are already successfully integrating citizen science, and reveal areas for improvement that could be addressed through training and capacity-building, policy measures and funding instruments, in order to maximize the impact and added value of citizen science initiatives.

Task 2.3 and the entire ScienceUs project are rooted in the policy context of the New European Research Area (ERA) framework, which seeks to engage and empower citizens and local communities to take action, co-design new solutions with the public to ensure widespread adoption and build a mutual trust between science and society.

Relation to the other WPs and tasks

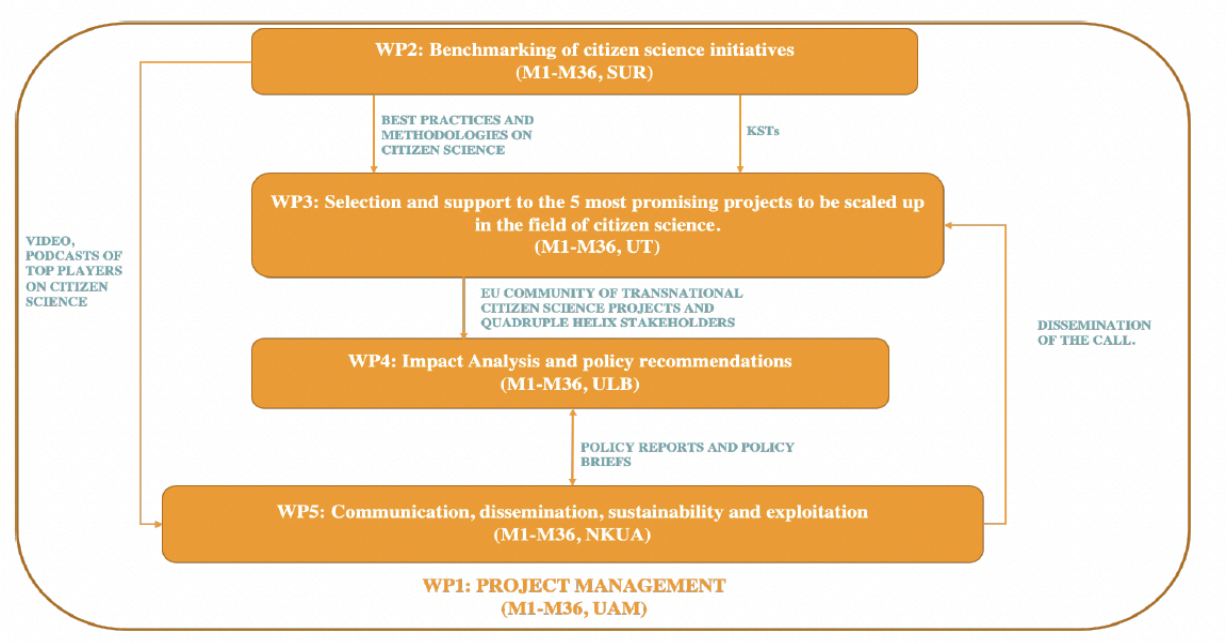

Fig. 1: Work package structure of the ScienceUs project

In addition to mapping challenges and opportunities, this deliverable serves as a foundational evidence base to inform future activities within other work packages of the ScienceUs project. In WP4, the insights gathered through task T2.3 will contribute to the development of policy recommendations aimed at enhancing the role of citizen science in climate change adaptation. Moreover, the findings presented here will guide the design of targeted training, mentoring, and networking events offered to participating projects within the ScienceUs Upscale Academy (WP3) by highlighting areas where additional capacity building and collaboration are most needed. In this way, the deliverable not only supports strategic planning but also helps ensure that upcoming ScienceUs project activities are grounded in real-world needs and experiences.

Document's purpose and structure

The structure of this report is designed to guide the reader through a comprehensive exploration of citizen science in the context of climate change adaptation. It begins by giving a

brief introduction to citizen science and climate change adaptation in the context of EU policy, with particular attention to the role citizen science can play in advancing the goals of the EU Mission "Adaptation to Climate Change" and the European Green Deal. A literature review then presents existing knowledge on the opportunities and challenges for citizen science in the field of climate change adaptation. The subsequent sections detail the methodology and data sources used in this report, followed by the presentation of key findings. In the discussion, results are summarised and organised into thematic areas. The report concludes with recommendations and reflections on best practices and enabling factors for harnessing citizen science to support climate change adaptation.

The status quo: citizen science and climate change adaptation in Europe

The policy context

Both citizen science and climate change adaptation have played an increasingly prominent role in European policy and research funding over the past ten years. In the following, we will provide a brief overview of EU policy goals and frameworks, strategic roadmaps, and funding programmes relevant citizen science and climate change adaptation.

Citizen science in EU policy and research funding

Whilst it is important to acknowledge that there is no singular definition of Citizen Science, for the purpose of this report it is conceptualized as "*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.*" (European Commission, 2020a).

In terms of EU-level policy support and funding for citizen science, the 8th EU Research and Innovation Framework Program, Horizon 2020, marked a significant milestone in the institutionalization and mainstreaming of citizen science within European research landscapes. Running from 2014 until 2020, Horizon 2020 explicitly recognized citizen science as an innovative approach to research and public engagement. Through the 'Science with and for Society' (SwafS) section within Horizon 2020 alone, a total of 25 projects focusing on citizen science received cumulative funding amounting to EUR 65 million. A CORDIS Results Pack

published in 2022 showcases the invaluable contributions these projects made to the development of good practice in the field of citizen science. The current framework program, Horizon Europe (2021-2027), continues to highlight the importance of citizen science while placing particular emphasis on co-design and co-creation processes, as well as on the mainstreaming of participatory research practices throughout the European research and innovation system. To this end, citizen engagement is incorporated across multiple thematic clusters and Missions within Horizon Europe, addressing a wide range of societal and environmental challenges.

But while funding remains a crucial enabler for citizen science initiatives, it is only one piece of the puzzle. Equally important are the broader forms of policy support that help create an enabling environment for citizen engagement in science. Beyond financial instruments, the EU has also promoted citizen science through strategic guidance, mutual learning opportunities, and its inclusion in key policy roadmaps and strategic documents. In 2020, the European Commission initiated a campaign to revitalize the European Research Area (ERA) with the aim of fostering a closer alignment between the member states' research policies and programmes. The joint aims and principles of this new ERA are outlined in the Pact for Research and Innovation in Europe adopted in 2021, which names "increasing society's participation in the ERA" as a key priority (European Commission: Directorate General for Research and Innovation, 2022b). The ERA Policy Agenda 2022-2024, in turn, identified citizen science as a key tool in promoting this societal engagement in research and innovation.

Adaptation to climate change means taking action to prepare for and adjust to both the current effects of climate change and the predicted impacts of the future (European Commission, 2021). Adaptation is not a one time emergency response, but rather a series of proactive measures to manage hazards, reduce exposure and mitigate vulnerabilities. Aside from physical adaptation to the environment, adaptation processes also encompass psycho-social, cultural and emotional dimensions (Hügel and Davies, 2020), reflecting the complex human responses to environmental change

At present, the EU is still underprepared for the inevitable impacts of a warming climate (European Environment Agency, 2024). In response, the European Commission has over the past few years developed several policy frameworks, strategic roadmaps and funding programmes to tackle this urgent and complex challenge. A first EU Strategy on adaptation to climate change was presented by the European Commission in 2013. It identified three policy priorities: (1) encouraging Member States to take action, (2) closing knowledge gaps to allow for evidence-based decision-making, and (3) promoting climate resilience in particularly vulnerable sectors. In 2019, the European Commission put forward the European Green Deal, a policy framework geared towards reducing greenhouse emissions and decoupling economic

growth from resource use in which adaptation to climate change is a central theme. The policy goals and priorities reflected in the EU Adaptation Strategy and the European Green Deal have had a strong impact on the thematic orientation and funding priorities of both Horizon 2020 and its successor, Horizon Europe. For instance, the Green Deal call - the last and largest call under Horizon 2020, provided €1 billion in funding to projects in the field of climate adaptation, resilience and achieving climate neutrality. In 2021, the European Commission adopted an updated EU Adaptation Strategy, which represents a strong commitment towards stepping up action to achieve climate resilience throughout the EU by 2050 (European Commission, 2021). This strategy is composed of four principle objectives: to make adaptation smarter, swifter and more systemic, and to step up international action on adaptation to climate change (European Commission). These objectives are to be reached by improving knowledge and awareness of climate impacts and possible adaptation solutions, accelerating adaptation planning and implementation at all governance levels, and conducting more comprehensive climate risk assessments (European Commission, 2021). The EU Mission "Adaptation to Climate Change", embedded within the current Horizon Europe research and innovation framework, operationalizes the objectives of the EU Adaptation Strategy by providing targeted support to EU regions, cities and local authorities. This support facilitates a better understanding of present and future climate risks, the co-development of pathways to be better equipped to deal with the changing climate, and the piloting and implementation of innovative, on the ground solutions to increase resilience. So far, 32 projects have been funded directly through the Mission, while 132 projects are affiliated with it in other ways. By 2030, at least 150 European regions and communities are expected to receive support to bolster their efforts to build climate resilience, according to the Mission´s objective.

Citizen science for climate change adaptation in EU policy and research funding

The European Commission recognises that meaningful climate action necessitates a collaborative, cross-sectoral approach that unites research institutions, industry stakeholders, policymakers, and civil society. This understanding is reflected in the EU's strategic frameworks to both climate change adaptation and citizen engagement, underscoring the centrality of participatory governance. Flagship initiatives like the European Green Deal and the Horizon Europe Missions emphasise the importance of bottom-up, participatory approaches—placing citizens not just as passive beneficiaries, but as active agents in driving the transition towards

climate-resilient societies.[1] As a result, citizen science is increasingly seen as a pivotal instrument to bridge the gap between scientific knowledge and societal action, making it a natural point of convergence between EU policies on climate adaptation and those promoting public engagement in science. This convergence is exemplified by the Green Deal call under Horizon 2020, which explicitly encouraged the integration of citizen science activities in project proposals to enhance societal relevance and impact. Within the framework of the EU Mission "Adaptation to Climate Change", the Mission Implementation Platform MIP4Adapt has published a "DIY Manual for Stakeholder and Citizen Engagement in Climate Adaptation" which lists citizen science as a valuable tool for generating research data, monitoring environmental variables and the implementation of adaptation measures, and increasing scientific literacy and public engagement in science. The Stakeholder and Citizen Engagement Training Programme provides additional support to projects wishing to actively engage citizens in their work.

Illustrative examples of EU-funded projects that have successfully integrated participatory approaches include AURORA, which has developed a smartphone app that enables users to monitor and manage their carbon emissions and is establishing a sustainable energy community in Aarhus (European Commission, 2024a). The COMPAIR project empowered citizens across multiple European regions - including various underserved communities - to monitor air quality using low-cost sensors and open data platforms. Through the data collected the project was able to influence local environmental policy, foster behavioural change, and provided empirical evidence to inform urban planning decisions (European Commission, 2024b). ECF4CLIM is collaboratively developing and validating a competence framework for sustainability education to help schools take proactive measures in addressing climate change and its associated effects (European Commission, 2024c). Another notable Horizon 2020 project, GRECO, engaged owners of photovoltaic systems in participatory research on and the co-design of next-generation photovoltaic technologies (European Commission, 2022a).

Yet, despite growing institutional recognition of its value, citizen science remains underutilised in the field of climate change adaptation. Of 301 Horizon Europe projects to date that address climate change adaptation, only 29 have incorporated (or are still using) citizen science as a research approach.[2] This indicates a significant untapped potential for engaging citizens in efforts to build climate resilience. To better understand how this potential can be realised, this

[1]Quote from the European Green Deal: "Since it will bring substantial change, active public participation and confidence in the transition is paramount if policies are to work and be accepted." https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2019:640:FIN

[2]https://cordis.europa.eu/search?q=contenttype%3D%27project%27%20AND%20frameworkProgramme%3D%27HORIZON%27%20AND%20(%27climate%20change%20adaptation%27)%20AND%20(%27citizen%20science%27)&p=1&num=10&srt=Relevance:decreasing

report systematically explores the current opportunities, structural barriers, and operational challenges facing citizen science in the context of EU climate adaptation initiatives.

Literature review: Challenges for the EU Mission Adaptation to Climate Change and opportunities for Citizen science

In order to establish a comprehensive understanding of the current state of research on climate change and public participation, a literature review was conducted using EU publications and academic databases such as Google Scholar. Relevant publications were identified through targeted keyword searches including 'climate change', 'global warming', 'climate policy', 'climate adaptation', ´citizen science´, ´public participation´ and ´EU Mission´ etc. Additionally, ChatGPT (chat.openai.com) was used as a supplementary resource to assist in exploring research themes and clarifying complex concepts during the review process.

The next section outlines key challenges specific to the EU Mission "Adaptation to Climate Change" and explores how citizen science initiatives could help address or overcome them.

Challenge 1: Local and regional variability

Given the EU's geographic and socio-economic diversity, climate change will affect different regions in unique ways. Therefore, adaptation strategies need to be tailored to regional and local needs, whilst ensuring they are effective and equitable across regions. (European Commission, 2021). Due to these pronounced regional differences, a one-size-fits-all approach is not an adequate response to the growing threat that climate hazards pose (EEA, 2020).

Opportunity for citizen science

Citizen science is instrumental in co-developing adaptation strategies tailored to local environmental conditions and community-specific needs. Climate change impacts are often most acutely felt at the community level (Granderson, 2014), necessitating ongoing, localized adaptation efforts within these communities (Duerden, 2004; Moser and Pike, 2015). The EU Mission on Adaptation to Climate Change explicitly underscores the importance of enhancing regional and community-level resilience through inclusive, participatory approaches.

Actively involving affected communities through citizen science initiatives is an effective tool for adapting to and mitigating the impacts of climate change - empowering citizens to become active decision-makers and co-creators of solutions (Hügel and Davies, 2020). Such bottom-up approaches leverage local knowledge of vulnerabilities and personal experiences, enriching

adaptation strategies with granular insights into specific vulnerabilities and community dynamics (Cruz et al. 2025).

Initiatives like the EU-funded CLIMAS project exemplify this paradigm by co-designing climate adaptation tools in close collaboration with stakeholders, thereby ensuring that local values and knowledge systems are integral to the development of effective, inclusive strategies.

Challenge 2: Financing and Resources

Financial support for climate adaptation is available through a wide range of EU funds (e.g. Horizon Europe) and is integrated into all major EU spending programmes. However, given the escalating scope and complexity of climate-related challenges, there is a continuous need to increase investments into climate adaptation. Concerns have been raised regarding the adequacy of existing EU funding mechanisms for meeting the rising financial demand associated with comprehensive climate adaptation (European Court of Auditors, 2020).

Furthermore, ensuring that resources are efficiently distributed and effectively used at the local and regional level remains a challenge within the EU adaptation framework.

Opportunity for citizen science

Through collecting, processing, and analyzing data — activities traditionally reserved for professional scientists — citizen science initiatives can enhance the efficiency of data collection (Christine and Thinyane, 2021), providing a cost-effective way of gathering information, which is particularly valuable for organizations operating with limited budgets.

Additionally, many citizen science initiatives do not depend on expensive monitoring technologies, but instead utilize a variety of affordable, user-friendly tools, which, even if they have individual limitations, can collectively contribute to a more robust and reliable monitoring or forecasting system (Perez et al, 2023).

The use of low-cost monitoring equipment in citizen science projects can be particularly valuable in lower-income regions, where such tools complement national regulatory monitoring systems and contribute to the data needs of global frameworks, such as the UN Sustainable Development Goals (Guardian, 2025).

The advent of digital technologies, notably smartphone applications, has further accelerated the expansion of citizen science. These technologies make participation more accessible and efficient, enabling broader public engagement and facilitating cost-effective, large-scale data collection endeavours (Paul et al. 2018).

Challenge 4: Social Inequality and Vulnerability

Levels of exposure to climate hazards in the EU vary greatly across regions, economic and social conditions. (EEA, 2024). Climate change disproportionately affects vulnerable population groups, such as the elderly, women, persons with disabilities, and marginalized communities. Regions characterized by lower socio-economic status, such as certain areas in Bulgaria, Croatia, Greece, Italy, and Spain, are particularly impacted by high temperatures and long-term unemployment (EEA, 2018). In addition, countries with a high number of extreme heat days are often also characterised by populations with a higher proportion of elderly people - such as is the case in Greece, Italy, Portugal and specific regions of Spain (EEA, 2018). Intensified urbanisation exacerbates these challenges; approximately 46% of hospitals and 43% of schools in European cities are located in zones at least 2°C warmer than the regional average due to the urban heat island effect (EEA, 2022).

Socioeconomic inequalities and an ageing population increase disparities in vulnerability and exposure to climate risks. Vulnerable groups often face systemic barriers to accessing adaptation measures, such as affordable cooling systems, flood-proofing and equitable access to green spaces, due to financial constraints and spatial inequities. Effective adaptation strategies must address these disparities, providing tailored solutions that support vulnerable populations. Adaptation must be inclusive and equitable to avoid exacerbating social inequalities (IPCC, 2022).

Opportunity for citizen science

Citizen science enables research to be more responsive to societal needs, values, and expectations, addressing existing inequalities and vulnerabilities. Actively involving diverse communities in the research process ensures that scientific endeavors remain inclusive, culturally relevant, and capable of producing context-specific, socially robust solutions. This participatory approach can empower communities to contribute to and benefit from research outcomes.

Involving citizen scientists in the problem identification phase significantly enhances the contextual relevance and legitimacy of generated knowledge, ensuring it aligns with community needs and local priorities. This form of engagement not only empowers communities but also supports the Sustainable Development Goals (SDGs) by reinforcing the nexus between science and environmental governance, and inclusive participation in science and technology.

Improving public engagement and participation of citizens in climate research can increase awareness and motivate citizens to actively get involved and shape environmental policies. In turn, a more active participation of citizens in policy development can ensure that these are more closely aligned with the needs of the society in question and address environmental issue that impact communities directly, such as data collected through air quality monitoring projects (e.g. Compair and OpenSense) influencing urban pollution policies.

Challenge 5: Economic Transition and Job Losses

Sectors such as agriculture, fisheries, and tourism, are particularly susceptible to climate induced disruptions, given their direct dependence on environmental conditions and ecosystem services (Cinner et al, 2022; Hall et al, 2015). At the same time, the transition of these sectors towards more resilient and sustainable models may entail significant structural adjustments, including potential job losses. The EU is thus confronted with the dual challenge of ensuring workforce reskilling in vulnerable sectors and implementing comprehensive economic diversification strategies to foster the creation of green, sustainable employment opportunities. The EU has recognized this challenge at the policy level through initiatives such as the European Green Deal and the Just Transition Mechanism, both of which aim to ensure a socially equitable shift towards a low-carbon economy (European Commission, 2020b and 2022b)

Opportunity for citizen science

Citizen science can meaningfully contribute to facilitating just economic transitions and mitigating job losses associated with climate change by fostering community engagement, enhancing skill development, and supporting pathways towards the creation of green jobs. By active participation in environmental monitoring and data collection, citizen science initiatives not only raise public awareness but also equip individuals with practical competencies in data science, environmental assessment, and sustainability practices. Such empowerment enhances individual employability, particularly within emerging green sectors, and fosters a culture of environmental stewardship and innovation at the community level.

Furthermore, citizen science can also actively influence the local economy, through providing up-to-date environmental monitoring data. An example of this is the delisting of a marine fish species from the U.S endangered species act (ESA), through a combination of local ecological knowledge and expert volunteer contribution (Andrews et al. 2019).

Challenge 6: Integration of various levels of government structures in EU policy making

The multi-tiered governance structure within the EU, encompassing supranational, national, regional, and local authorities, often complicates the coherent coordination and implementation of climate adaptation measures. (Russel et al. 2020). While effective collaboration between EU institutions, national governments, regional bodies, and local communities is crucial for successful adaptation, it remains difficult to operationalize due to divergent priorities, administrative fragmentation, and varying institutional capacities. Initiatives such as the Urban Agenda for the EU and the EU Covenant of Mayors are initiatives that seek to enhance vertical and horizontal coordination by fostering multi-level governance structures and promoting collaborative climate action.

Opportunities for citizen science

Through a "bottom up" approach, citizen science can, to some extent, bypass the bureaucracy and logistical barriers inherent in intergovernmental and interregional coordination processes. In addition, through involving local stakeholders in participatory processes such as data collection and analysis, citizen science can enhance the legitimacy and perceived relevance of scientific findings, thereby increasing the willingness of policymakers to take responsive action (Haklay, 2013). This was exemplified in the UK, where, through support from the NGO Earthwatch Europe, citizens collected data on water quality, which played a vital role in shaping environmental policies by providing policymakers with transparent, community-sourced information. After the data exposed pollution issues, government agencies were prompted to investigate and subsequently incorporate the citizen-derived data into official monitoring systems (Hadj-Hammou et al, 2017). Such grassroots scientific efforts demonstrate how community-driven data collection can lead to broader policy changes beyond the local context.

This interaction between citizens and policy makers can lead to the creation of positive feedback loops, enhancing transparency, accountability, and mutual legitimacy between authorities and communities (Skarlatidou et al. 2024). Such collaborative approaches enhance procedural transparency and demonstrate a tangible commitment to inclusive governance, thereby increasing public confidence in institutional actions (UNEP, 2024).

When institutions actively support CS projects, they signal a willingness to incorporate citizen input into decision-making processes, thereby strengthening the relationship between the public and governing bodies. This support not only legitimizes citizen contributions but also fosters a sense of shared responsibility and transparency in addressing environmental challenges. (Skarlatidou, 2024).

Challenge 7: Knowledge Gaps and Data Sharing

A critical need persists for a more granular and sector-specific understanding of the multifaceted impacts of climate change on domains such as agriculture, public health, and labour markets. Overcoming knowledge gaps and improving data interoperability and sharing among stakeholders are essential prerequisites for developing robust, evidence-based adaptation strategies. The lack of comprehensive, high-resolution data and effective systems for sharing information can impede timely and efficient action (EEA, 2020).

Opportunities for citizen science

Citizen science can play a key role in addressing data deficiencies by involving non-professionals in the systematic collection and analysis of environmental data, enhancing both the volume and heterogeneity of datasets. The participatory approach enables citizens to engage in tasks and processes traditionally limited to professional scientists, thereby improving the spatial and temporal resolution of data while improving overall collection efficiency (Christine and Thinyane, 2021).

Citizen scientists can expand data collection networks through increased geographical coverage, especially in remote or underrepresented regions, where traditional monitoring infrastructure is sparse or absent (Hecker et al., 2018). The ability to contribute data in real-time (using, e.g., apps) can play a key role in improving the responsiveness of climate monitoring systems by minimizing temporal delays and enabling more timely intervention during climate-related events.

Beyond local contributions, citizen science can support large-scale data generation, enhancing the robustness of climate models (through increasing the variety of data sources used) and predictions (Cohn, 2008) . Long-term monitoring projects, including iNaturalist (species distribution) and The GLOBE Program (environmental change), exemplify how sustained citizen involvement can contribute to comprehensive, longitudinal climate data repositories (Hu et al. 2025).

Although citizen-generated data may not always match professional quality, many projects do not necessarily require high precision, but can instead use a multitude of affordable, simple tools with lower reliability, which in sum can create a more effective overall monitoring system (Perez et al., 2023). Citizen science data can be utilised to meet local needs, like early flood warnings for example, where it can be merged with traditional data to improve forecasting (Alemu et al. 2023).

Challenge 8: Long-term Planning vs. Immediate Action

Effective climate adaptation requires long-term planning, but political cycles, budget constraints, and the urgency of the issue often push for immediate actions. Balancing long-term adaptation goals with the need for immediate responses to current climate challenges is a significant challenge. The EU's adaptation strategy aims to integrate long-term planning with short-term actions, but achieving this balance is an ongoing difficulty (European Commission, 2021).

Opportunities for citizen science

Due to the "bottoms up" nature of citizen science, it is less constrained by external timelines and can provide versatile and flexible solutions – e.g., long-term monitoring and observation vs immediate action. This flexibility makes citizen science an attractive tool for policy makers, strengthening both aspects of the EU´s adaptation strategy: long-term planning and short term actions.

Furthermore, citizen science can have long term effects through positively influencing public attitudes and behavior toward climate change adaptation by raising awareness of environmental issues. For example, monitoring programs help participants understand complex connections, like the ecosystem services provided by forests (Van Risjoort and Jinfeng, 2005). A very successful European example of this are the *Plastic Pirates*, which has engaged youth across the continent in tracking plastic waste and has influenced waste management policies (Nelms et al. 2022).

Thus, citizen science can enhance the EU´s adaptation strategy by increasing awareness and understanding of long-term adaptation to climate change.

Literature review: Challenges for citizen science in the context of adaptation to climate change

Despite widespread public awareness of the risk posed by climate change and the urgent need to take action, levels of active public engagement remain quite low (Cruz et al. 2025). While

citizen participation is increasingly emphasized in EU adaptation policies (e.g., Horizon Europe, 2021), this lack of engagement limits the effectiveness and societal reach of adaptation efforts, significantly hindering successful adaptation. The following section will share a brief literature review of the challenges for citizen science (and public engagement in a wider sense) in the context of adaptation to climate change.

Low levels of citizen participation

Many citizen science projects face difficulties in scaling participation, because they are confined to specific geographic locations and communities. This is exacerbated by challenges in the following domains:

Communication

Ineffective communication strategies and lack of inclusive outreach efforts can reduce participation in citizen science initiatives. Technical language often alienates potential participants by failing to align with their values (Hendersson & Wamsler, 2020), while unclear guidelines and complex equipment can hinder sustained engagement (Hyder et al., 2017). Descriptions of the project itself are also crucial, as these often represent the first point of contact with prospective participants - thus, the communication style deployed needs to spark interest, whilst also relaying the necessary practical information (Golumbic and Oesterheld, 2023).

In the context of climate change, these communication challenges are intensified - as climate change is characterised by complexities and uncertainties, making this phenomena difficult to contextualize at the individual level. Complexities include, amongst others (perceived) distant impacts and lack of immediacy, as well as the lack of gratification for taking mitigative actions (Moser, 2010). Thus, if the narrative and communication style of the citizen science initiative does not address cultural, socioeconomic and psychological factors - a disconnect can develop in which individuals do not recognise the risk of climate change as relevant to them and therefore do not perceive agency (Hendersson and Wamsler, 2020). Furthermore, as the perception of risk is a mental construct and risk perception has been indicated to be an important predictor of public willingness to engage in sustainable practices (Leiserowitz, 2006). Climate change risk perceptions can vary greatly and are influenced by cognitive, experiential and socio-cultural factors (van der Linden, 2015).

A lack of effective engagement of stakeholders at the community level is a challenge for climate change adaptation, as this can hinder progress and prevent sufficient scaling of initiatives (e.g. through training programs) (Moser and Pike, 2015).

Psychology

Climate change is still perceived by many as a remote, indirect or abstract threat, which diminishes the perceived immediacy of the issue (Geiger et al, 2022 ; van der Linden, 2015). This perception can result in limited public engagement with climate change (Geiger et al, 2022) or motivation to participate meaningfully in adaptation strategies, including citizen science initiatives.

In formulating effective climate change adaptation strategies, it is crucial not to overlook the psychosocial and behavioral aspects that influence individual and community responses (van der Linden, 2015).

Individual's perception of climate risk will influence their readiness to engage with adaptation initiatives and strategies (Aronsson & Schöb, 2018). Perceptions are influenced by numerous factors, including personal experiences (Reser et al. 2020), worldviews, social norms and levels of trust in government and institutions (Spence et al. 2011, Whitmarsh et al. 2013).

Taking into account the affective dimension - the emotional response to climate change- when trying to enhance citizen engagement, is crucial, as emotions significantly influence the motivation of individuals to act. Whilst emotions such as fear, helplessness and denial act as a hindrance, feelings of hope, concern and empowerment can encourage proactive behaviour (O'Neill & Nicholson-Cole, 2009). Individual's sense of efficacy and coping strategies play a critical role in shaping individuals' willingness to engage in adaptation actions, highlighting the importance of integrating psychological factors into adaptation planning and policy development (Truelove et al. 2015).

Therefore, citizen science initiatives that want to foster long term engagement with climate adaptation can not limit their communication efforts to technical or informational strategies, but must incorporate emotional and socio-psychological dimensions. For example, framing climate change impacts as immediate and local can increase engagement, by reducing psychological distance of climate change (Jones et al. 2017).

Maintaining long term engagement

The motivation driving citizens voluntary participation is the product of a complex interplay of individual motivations and external influences (West & Pateman, 2016) and a differentiation needs to be made between the initial engagement (often driven by intrinsic motivation,

curiosity and the desire to learn) and sustained engagement (which results from intrinsic, external and collectivistic factors) (Delfine et al. 2024).

Limited incentives can undermine long-term citizen engagement, especially without clear benefits or visible outcomes. Monotonous tasks, insufficient training, or overly complex activities further reduce motivation to stay involved (Delfine et al., 2024).

Whilst financial incentives or the prospect of self-enhancement can increase initial motivation, achieving sustained participation over a longer time frame is reached by drawing on intrinsic values and factors - such as fairness, opportunities to gain new knowledge and skills and receiving feedback, personal mentoring and a sense of accomplishment (von Gönner et al, 2023; Palacin et al. 2020). Numerous examples have shown that monetary incentives alone are not sufficient to achieve sustained participation (Defline et al. 2024).

However, other incentive methods deemed effective (beyond monetary incentives) - can require significantly more time and resources to put into place and maintain - such as providing periodic feedback to participants (Tinati et al. 2015), gamification (Tinati et al. 2017) and aligning incentives with participant´s motives (Moghaddam et al. 2023).

Diversity and Inclusion

Achieving diversity in citizen science initiatives can be challenging, as self-selection tends to favor individuals who have benefited from higher education, have sufficient economic resources to afford the equipment and time to participate, and live in areas of political stability. This can result in those who do not have these characteristics being underrepresented, which often includes those from marginalized and Indigenous populations (Paleco et al. 2021).

In the context of climate change, this is of course particularly relevant, as climate change tends to disproportionately affect those already worse off. A lack of diversity in CS initiatives limits the range of perspectives, knowledge, and experiences that contribute to understanding and addressing climate-related challenges, such as valuable ecological knowledge that can improve climate adaptation strategies. Furthermore, increased diversity can lead to a higher chance of the development of innovative and creative solutions.

Failing to include marginalised communities can lead to the development of adaptation strategies that do not address their specific and localised needs. It can also decrease trust in scientific policies and adaptation strategies, as certain groups of citizens do not feel heard or included in the decision making process.

Data quality and ownership

If ownership rights are not clear, adaptation response efforts can be delayed, as key stakeholders (citizens, scientists, policy makers etc.) may have difficulties accessing data to develop adaptation strategies (Cooper et al. 2021). If ownership of the data does not remain in the community, this can lead to a loss of trust in the initiative by participating citizens, as they do not have control or see the benefit of the data they collect. This can also threaten future engagement in CS initiatives and the sustainability of longer-term projects.

Currently, there is still a significant gap between citizens and academic scientists when it comes to sharing knowledge and data. The data and information collected by citizens frequently does not get used by academic scientists and, on the other hand, the research produced by the academic is often blocked by paywalls - hindering access for the citizen scientists (Wildschut, 2017).

The issue of uncertainty in regard to data quality remains one of the most discussed aspects in the field of citizen science (Lukyanenko et al. 2019). Several challenges are present, including concerns of accuracy and reliability (due to variability in the expertise and consistency of those collecting the information). Furthermore, a lack of standardisation and validation processes, such as cross-checking with professional datasets or experts, can complicate the process of integrating datasets across regions and projects and hinder comparability. In turn, this reduces the usability of the data. Incomplete and inconsistent reporting (spatial and temporal), coupled with the challenge of ensuring diversity (addressed in the previous section) can exacerbate biases and could negatively impact the development of fair and equitable climate adaptation strategies (Fritz et al. 2022).

Ensuring that citizen scientist initiative possess the capacity and skills needed to collect and manage data in a scientifically rigorous way is crucial to ensure data quality. This does not mean that the participants themselves need to be experts, but that there must be interdisciplinary collaboration and outsourcing of tasks that require specialist skills (e.g. building a website or an app etc.)

Institutional and financial barriers

The success of citizen science initiatives can be threatened by limited institutional support and recognition (e.g. by not valuing the data collected) and lack of sustained funding. Funding and support is necessary to ensure that participants can be adequately trained and data sufficiently validated, as well as minimising potential drawbacks for citizens, such as feeling overburdened or disempowered by the process of lack of visible results. However, project-based funding and lack of long-term funding and internal resources at institutions can make it difficult for them to provide continuous support to citizen science initiatives over a longer time frame.

Many universities and research institutions are still more primed towards "traditional", expert-driven data collection methods - as opposed to looking to include participatory methods. As mentioned in the previous section, concerns regarding data quality, ethics and intellectual property can complicate the situation, leading academics and researchers to avoid collaborating with citizen science initiatives (EUA, 2025).

Without the support of institutions, the chance for citizen science initiatives to impact national adaptation strategies remains low, as data collected by citizens is likely to remain unused in official decision making processes. In order to make a difference, local knowledge and lived experiences need to be valued by decision makers (Sprain, 2017).

A lack of institutional support can also act as a barrier for increasing engagement and participation with citizen science initiatives, due to low levels of trust. This is particularly relevant for the topic of climate change adaptation, where governments and institutions are already frequently perceived as not doing enough or not taking the matter seriously.

Institutions can also provide resources, like access to AI, which can strengthen citizen science initiatives. Without their support, citizen science initiatives risk becoming "missed opportunities" when it comes to contributing towards climate change adaptation strategies.

Exploring added value, barriers and enabling factors of citizen science initiatives in the field of climate change adaptation

Methodology and Data Analysis

As explained above, the purpose of this deliverable is to examine how citizen science can contribute to EU climate adaptation goals, identify the barriers currently limiting citizen science in this context, and highlight areas where it can add the most value. In order to achieve this objective, we followed a triangulated approach, incorporating both qualitative and quantitative data collected through multiple channels.

As a first step, the MfN team reached out to active Horizon 2020 and Horizon Europe projects in the field of climate change adaptation that are not yet using citizen science and invited them to participate in a short survey (Survey I) on the potential application and added value of CS in their projects. Relevant projects were identified by searching the CORDIS database, using the following filters:

- Programme: “Horizon Europe framework programme”, “Horizon 2020 framework programme”
- Keywords: "climate change adaptation" and "climate resilience", excluding the keyword "citizen science"
- Project end date: after 1 September 2024

In total, 212 projects were directly contacted via email. To broaden outreach, the first survey was also promoted through the ScienceUs project website and social media channels. In compliance with the GDPR principle of data minimisation, it was conducted anonymously, without collecting any personal data, via the German survey tool “SoSciSurvey” (https://www.soscisurvey.de/). Ultimately, the survey, which was online from late May until early September 2024, received 52 complete and valid responses. Due to the broader dissemination via social media, 8 of these responses relate to projects that are already working with citizen science. These responses were excluded from the analysis.

The survey was designed to explore the interest, potential, and perceived challenges related to integrating citizen science into projects focused on climate change adaptation. Respondents were first asked to identify their project and indicate whether they were interested in incorporating citizen science, with options including "yes," "no," or "not sure yet." For those open to the idea, the survey invited further reflection on how citizen science could be applied in their specific context, including relevant topics or research questions, and the ways in which citizen involvement might contribute to achieving project goals. Multiple-choice options covered a wide range of possible contributions—from data collection and analysis to co-creation, testing solutions, raising awareness, and fostering behavioural change. To better understand potential barriers, respondents were asked to describe obstacles they foresee in implementing citizen science activities. The survey also gathered insights on key criteria for successful collaboration with citizen science initiatives and concluded with a question on what types of support—such as guidance on volunteer recruitment, data management, legal aspects, or policy engagement—would be most useful to facilitate the integration of citizen science into their work.

To complement this first dataset and add a second perspective, the MfN team then contacted EU-funded projects that already have a citizen science component and invited them to participate in a similar online survey between late March and mid-April 2025 (Survey II).

All in all we contacted 29 Horizon Europe projects, which were selected via a search in the Cordis Database, filtering for the keywords "climate change adaptation" and "citizen science". We chose these search criteria to ensure that these projects were clearly associated with the EU Mission "Adaptation to Climate Change" and were involving citizen science - to ensure that they would be able to provide information on the opportunities and challenges for citizen science in this context based on their own experiences.

Out of the 29 Horizon Europe projects contacted, 11 completed the survey: Adaptation Agora, NATALIE, AD4GD, NATURE-DEMO, GreenInCities, DRYAD, PYRENEAN CLIMATE CHANGE OBSERVATORY, IDAlert, Med-IREN, Regions4Climate and MountResilience, Precilience and CLIMAS project. Some of the projects we invited to participate apparently forwarded our email. As a result, the project Pyrenees Climate Change Observatory (OPCC) also completed the survey.

For the purpose of comparing and contrasting the two survey datasets with each other, we have sorted the survey questions into the following thematic categories in Table 1.

Thematic Category	Survey 1 Question(s)	Survey 2 Question(s)

Demand for/interest in CS	Would you be interested in integrating citizen science into your project?	
Opportunities for and added value of CS in the context of CCA	In connection with which topics, issues or research questions relevant to climate change adaptation could citizen science activities be implemented in your project?	What opportunities do you see for the application of citizen science in the field of climate change adaptation?
	How could citizen science activities best contribute to reaching your project goals?	What is the added value of incorporating CS in your projects?
Challenges and barriers for CS in the context of CCA	What do you think could be barriers or obstacles to implementing citizen science activities in the context of your project?	What challenges do you see for the application of citizen science in the field of climate change adaptation?
	In which of the following areas would you appreciate some support or guidance to help you plan and implement citizen science activities?	What challenges/obstacles to implementing CS in your project have you experienced/do you expect to experience?

Table 1: Thematic alignment of the two survey datasets

In addition to these two complementary online surveys, three semi-structured follow-up interviews were carried out with IDAlert, Adaptation Agora and the Precilience Project. These short, 20-30 minute interviews were recorded, summarised and evaluated in order to analyse the most important aspects of the responses based on the research interest.

Furthermore, input was gathered via a feedback form from 7 of the projects that participated in the ScienceUs Upscale Academy Bootcamp in Berlin in March 2025.

All responses to open-ended questions were coded manually by three members of the MfN team.

Results

Since the sample size of our surveys was not large enough to apply inferential statistical methods, we limited our analysis to descriptive statistics. The participants' response behavior is described in percentages and structured according to the thematic categories outlined in the previous section. All graphs in this section were created using the free data visualisation tool Flourish.

Interest in citizen science among EU-funded research projects

As one of the aims of WP2 is to assess interest in or demand for citizen science within the research community around climate change adaptation, participants of Survey I were first asked whether they would be interested in integrating citizen science into their projects. Figure 2 shows that 72.7% of respondents confirmed that they are interested in using citizen science, while 22.7% are still undecided and 4.5% see no added value in integrating citizen science into their projects.

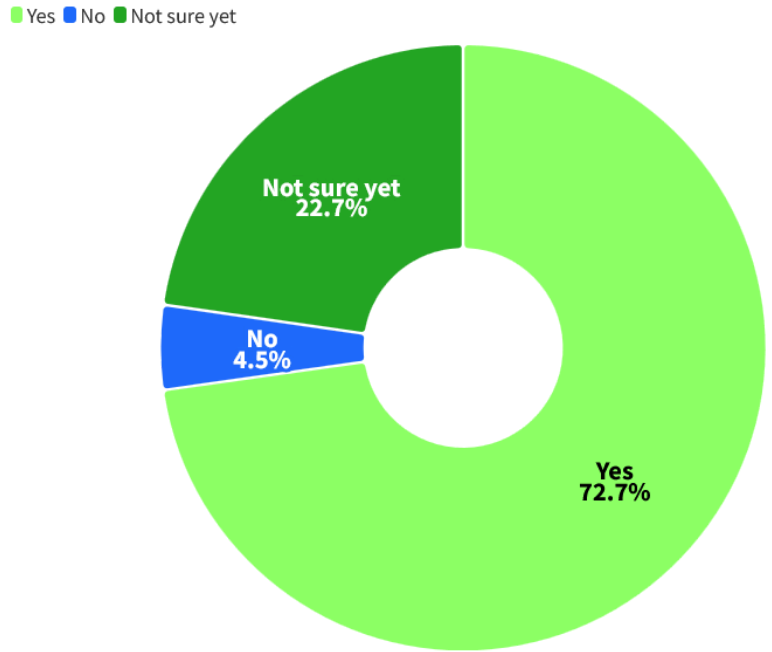

Fig. 2: Responses to the question "Would you be interested in integrating citizen science into your project?" as answered by participants of Survey I.

Opportunities for and added value of citizen science in climate change adaptation

Within the thematic category of "opportunities for and added value of CS in the context of CCA", Survey I contained two questions - one open-ended question on topics, issues or research questions in connection with which citizen science could provide added value, and one multiple-choice question pertaining to ways in which citizen science could contribute to project goals.

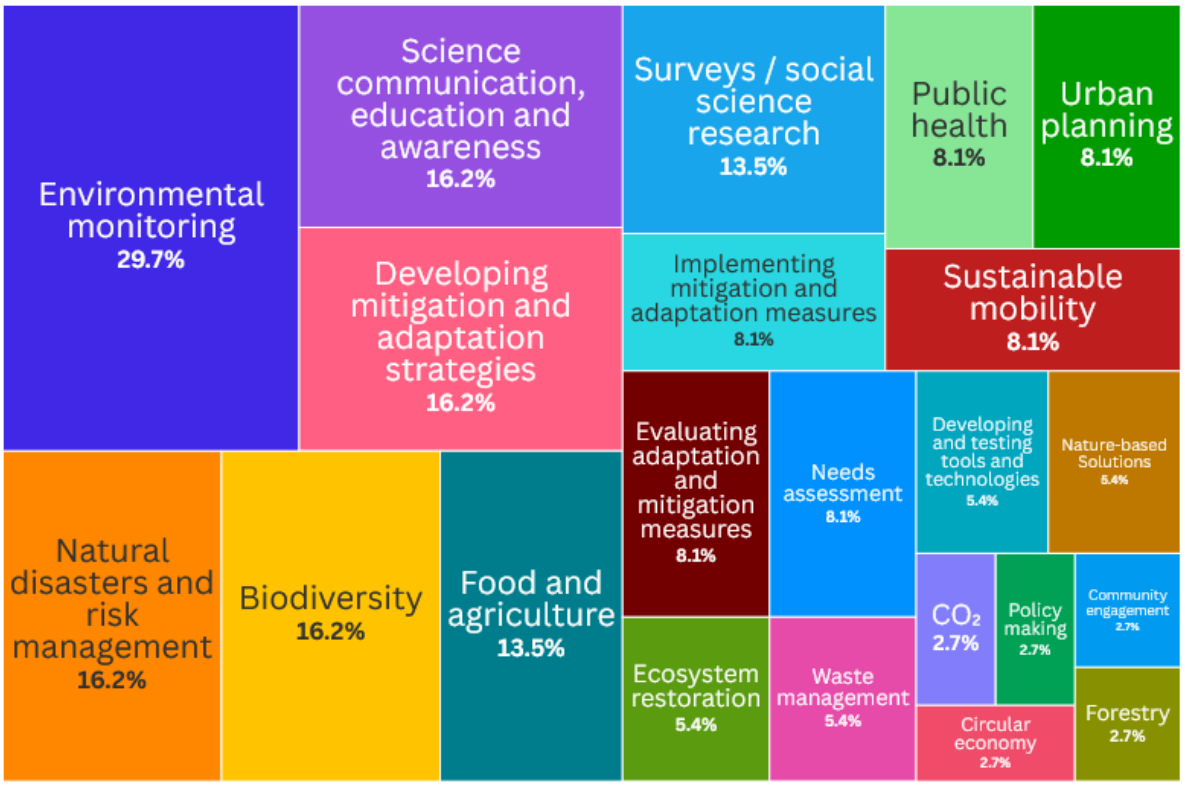

Fig. 3: Summary of the diverse thematic areas and research fields in which respondents from Survey I identified potential for the application of citizen science in climate change adaptation.

The responses to this question reveal a diverse range of thematic priorities and application areas where respondents see potential for citizen science in the context of climate change

adaptation (Figure 3). The most frequently mentioned area was environmental monitoring, underscoring the perceived value of citizen-generated data in tracking local environmental conditions. This was followed by strong interest in climate adaptation and mitigation strategies, including the development, implementation, and evaluation of such measures, as well as related needs assessments. Communication, education, and awareness also featured prominently, highlighting the importance of citizen science not only as a data collection tool but also as a means of sharing knowledge and fostering behavioural change.

In addition, several respondents pointed to the relevance of citizen science for protecting and restoring biodiversity and ecosystems, as well as for supporting risk management in the face of natural disasters. Other suggested application areas include urban planning and sustainable mobility, public health, food and agriculture, and waste management—reflecting the potential of citizen science to contribute across a wide range of sectors. Finally, several responses emphasized the value of citizen science for social science research, and for the development and testing of tools and technologies, further underscoring its interdisciplinary and cross-cutting character.

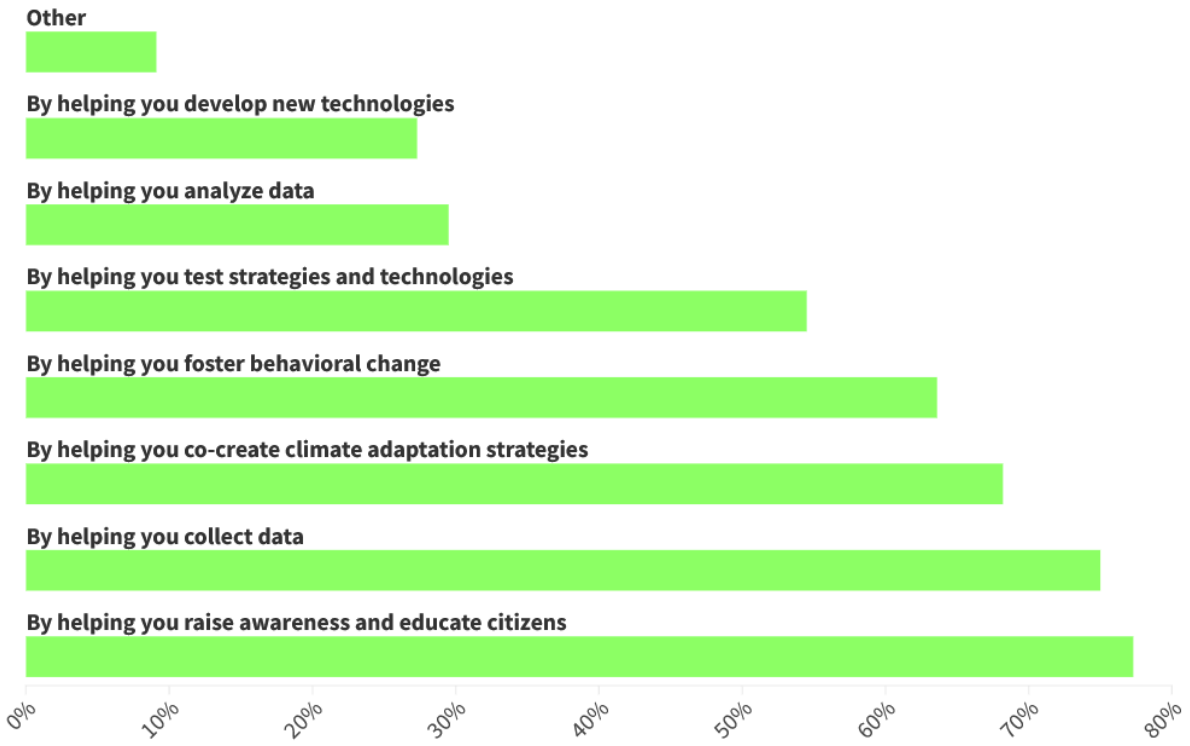

Fig. 4: Responses to the question: "How could citizen science activities best contribute to reaching your project goals?" as answered by participants in Survey I.

Responses to the question “How could citizen science activities best contribute to reaching your project goals?" (Figure 4), indicate that the survey participants primarily view citizen science as a valuable tool for **raising awareness and educating citizens** (selected by nearly 80% of respondents) and **collecting data** (approximately 75%). These findings underscore the dual importance of citizen science in both knowledge dissemination and the generation of empirical data to support climate change adaptation efforts.

Additionally, a substantial proportion of respondents recognized the potential of citizen science to support **the co-creation of climate adaptation strategies** and to **foster behavioral change**, with both options selected by over 60% of participants. These responses highlight the perceived relevance of participatory approaches not only in informing project implementation but also in enhancing community ownership and long-term impact.

Less frequently cited were contributions related to **testing adaptation strategies and technologies** (around 50%), **data analysis**, and **technology development** (approximately 30% and 20%, respectively), suggesting that while citizen science is valued for its collaborative and educational functions, its role in more technical or specialized project components may be perceived as more limited.

9% of respondents selected “Other”, citing for instance potential contributions to policy-making in the field of sustainable mobility, to the local implementation of adaptation measures, and to the dissemination of project results.

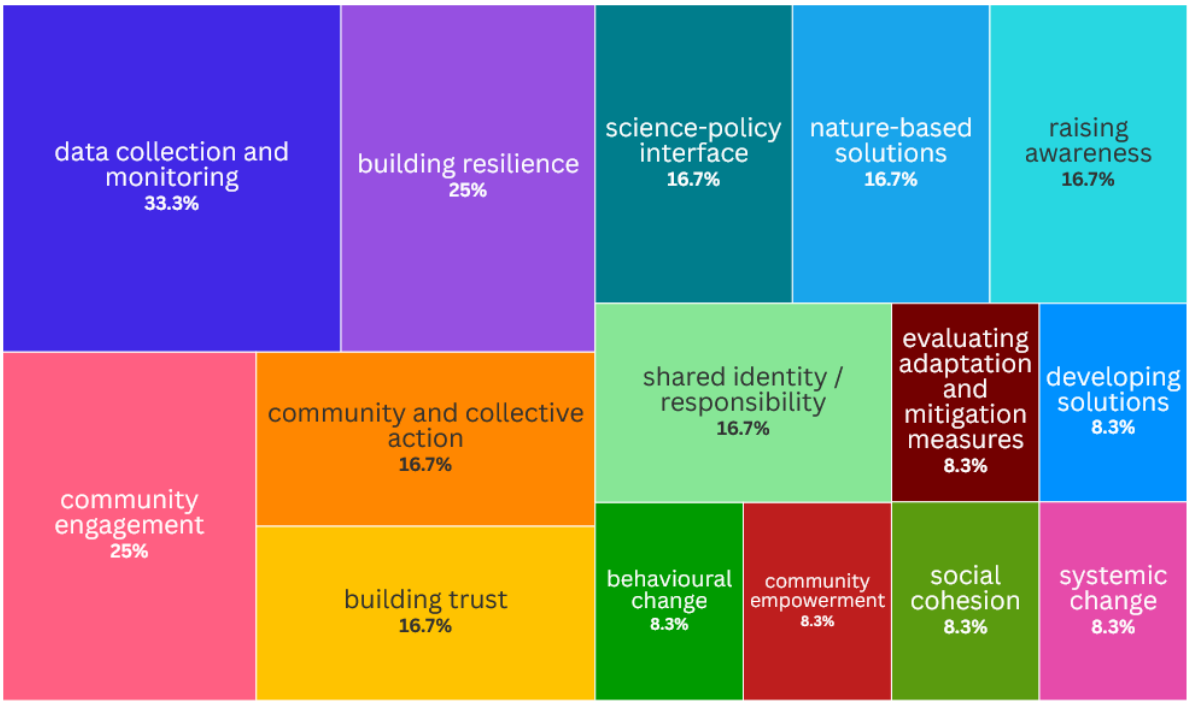

Fig. 5: Opportunities for the application of citizen science in the field of climate change adaptation, as identified by participants in Survey II. Respondents answered the question: "What opportunities do you see for the application of citizen science in the field of climate change adaptation?".

Projects already using citizen science in the context of climate change adaptation identified a range of opportunities for further leveraging participatory approaches in this field (Figure 5). The most frequently mentioned opportunity was in the area of **data collection and monitoring**, cited in 33% of responses. Projects saw strong potential for citizen science to contribute localized, timely, and cost-efficient data to support climate adaptation planning and implementation.

Closely following were opportunities related to **resilience-building** and **community engagement**, each highlighted by 25% of respondents. These responses pointed to the role of citizen science in fostering both environmental resilience and social resilience by enhancing local capacity and participation in adaptation efforts.

Several projects emphasized the value of **community and collective action** (16.7%), identifying citizen science as a tool to bring people together around shared climate goals. Related to this were mentions of **trust**, **shared identity and responsibility** (16.7% each), and **social cohesion** (8.3%)—all seen as key ingredients for sustained community involvement and collaborative adaptation strategies.

The role of citizen science in bridging the **science-policy interface** was also noted in 16.7% of responses. Respondents suggested that citizen-generated data and insights could support more inclusive and informed policymaking. Similarly, **nature-based solutions** (also mentioned in 16.7% of responses) were identified as a promising area for citizen science involvement, offering both ecological and community co-benefits.

Other opportunities included the potential for citizen science to support **awareness-raising**, **behavioural change**, and **community empowerment**—all critical for fostering long-term engagement and encouraging climate-positive actions. Additional mentions included the use of citizen science for **evaluating adaptation and mitigation measures**, **developing solutions**, and contributing to broader **systemic change**.

Taken together, the responses reveal a strong belief in the transformative potential of citizen science—not only as a tool for gathering information, but as a vehicle for empowering communities, shaping policies, and building the foundations for resilient, climate-adapted societies.

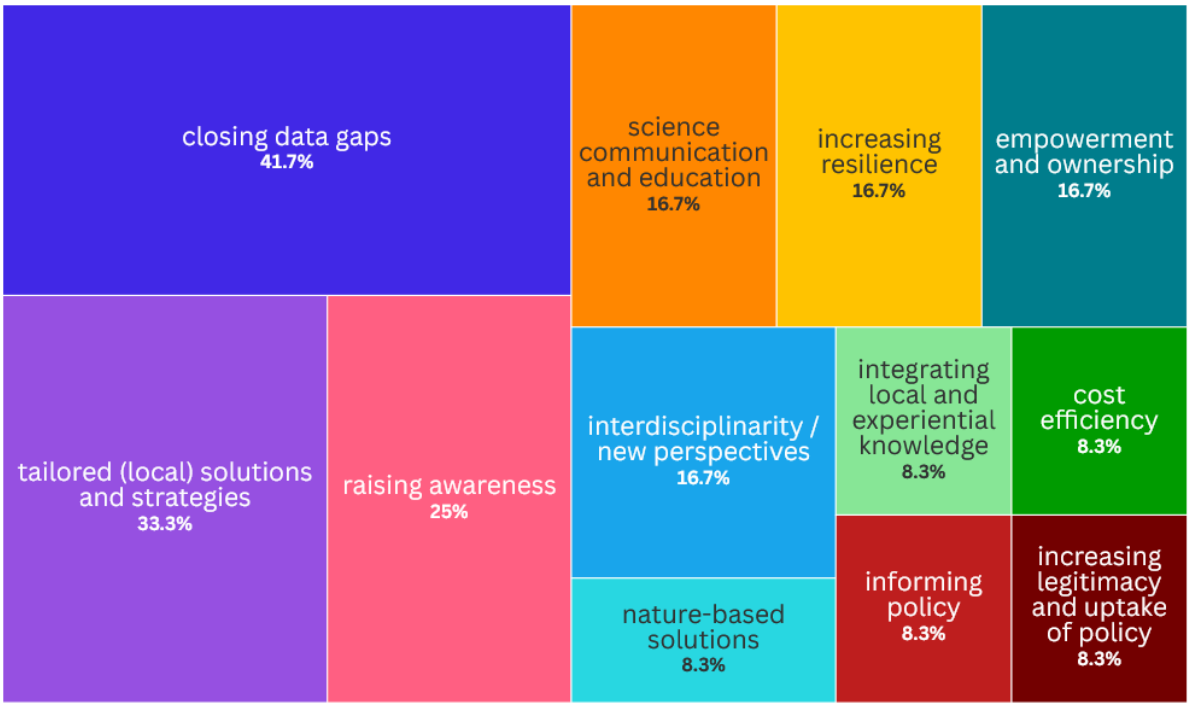

Fig. 6: Perceived added value of incorporating citizen science in ongoing climate change adaptation projects, based on

responses from Survey II. Participants answered the question: "What is the added value of incorporating citizen science in your projects?".

The responses from projects currently using citizen science paint a lively picture of its added value in the context of climate change adaptation (Figure 6). Among the most frequently cited benefits is the ability to **close data gaps** (mentioned 41.7% of responses), highlighting how citizen science helps generate valuable, often otherwise unavailable data — particularly at local or granular levels that traditional methods may overlook.

Another key advantage is the development of **tailored (local) solutions and strategies** (33.3%). Many projects found that citizen science enhances the relevance and effectiveness of their work by grounding it in local contexts, perspectives, and needs. Closely linked to this is the role of **awareness-raising** (25.0%) and **science communication or education** (16.7%), reflecting how citizen science fosters public understanding and encourages active engagement with scientific and societal issues.

Projects also emphasized the value of citizen science in building **resilience** and fostering **empowerment and ownership** (16.7% each), illustrating its potential to strengthen community agency and support longer-term, sustainable engagement. Similarly, **interdisciplinarity and new perspectives** were mentioned as important contributions, as citizen science often brings together diverse knowledge systems and fosters innovation through cross-sector collaboration.

In addition to these widely shared benefits, several projects highlighted more specific advantages. These include the promotion of **nature-based solutions**, the **integration of local and experiential knowledge**, and **cost efficiency** — each noted once. Finally, citizen science was also credited with enhancing the **legitimacy, relevance, and uptake of policy**, as well as directly **informing policy processes**.

The responses from projects actively using citizen science reveal a rich set of perceived benefits, which can be grouped into several thematic areas that together highlight the multifaceted value of incorporating citizen science into research and practice.

A central theme is data and knowledge generation, with many projects emphasizing that citizen science helps to close existing data gaps. This contribution was the most frequently cited, underlining the role of citizen involvement in producing richer, more comprehensive datasets. Beyond quantity, the integration of local and experiential knowledge, as well as the introduction of interdisciplinary and novel perspectives, shows how citizen science can enhance the quality and depth of insights by diversifying the sources and types of knowledge used.

Closely connected to this is the theme of local relevance and adaptation. Several projects stressed that citizen science enables the development of tailored solutions that are responsive to specific local contexts. These locally grounded approaches are often more effective and more likely to be adopted by communities. In some cases, this value is further linked to the promotion of nature-based solutions, which rely heavily on an understanding of local ecosystems and community needs.

Another key area is community engagement and empowerment. Citizen science is seen not only as a method of data collection, but also as a way to foster greater ownership, involvement, and resilience within communities. By participating in the research process, community members can feel more empowered and connected to the outcomes, which in turn supports longer-term engagement and sustainability of project impacts.

The value of citizen science in raising awareness and supporting education was also highlighted. Projects pointed to its role in strengthening science communication and public understanding of complex issues, which is crucial for fostering informed decision-making and behavioral change. Through participation, citizens become more informed and more likely to engage with science and policy in meaningful ways.

Some responses also underscored the policy-related impacts of citizen science. These included its ability to inform policy development with real-world, grounded insights, and to increase the legitimacy and uptake of policy decisions by involving citizens directly in the knowledge creation process. This positions citizen science as a tool for enhancing the democratic legitimacy and relevance of policy-making.

Finally, a smaller number of projects noted practical benefits, such as cost efficiency. This reflects the view that citizen science can be a resource-effective approach, making it attractive to projects operating with limited budgets or seeking scalable solutions.

Together, these themes illustrate that citizen science is not only a valuable scientific method but also a powerful tool for social engagement, local empowerment, and policy influence — making it a highly versatile approach for projects aiming to achieve real-world impact.

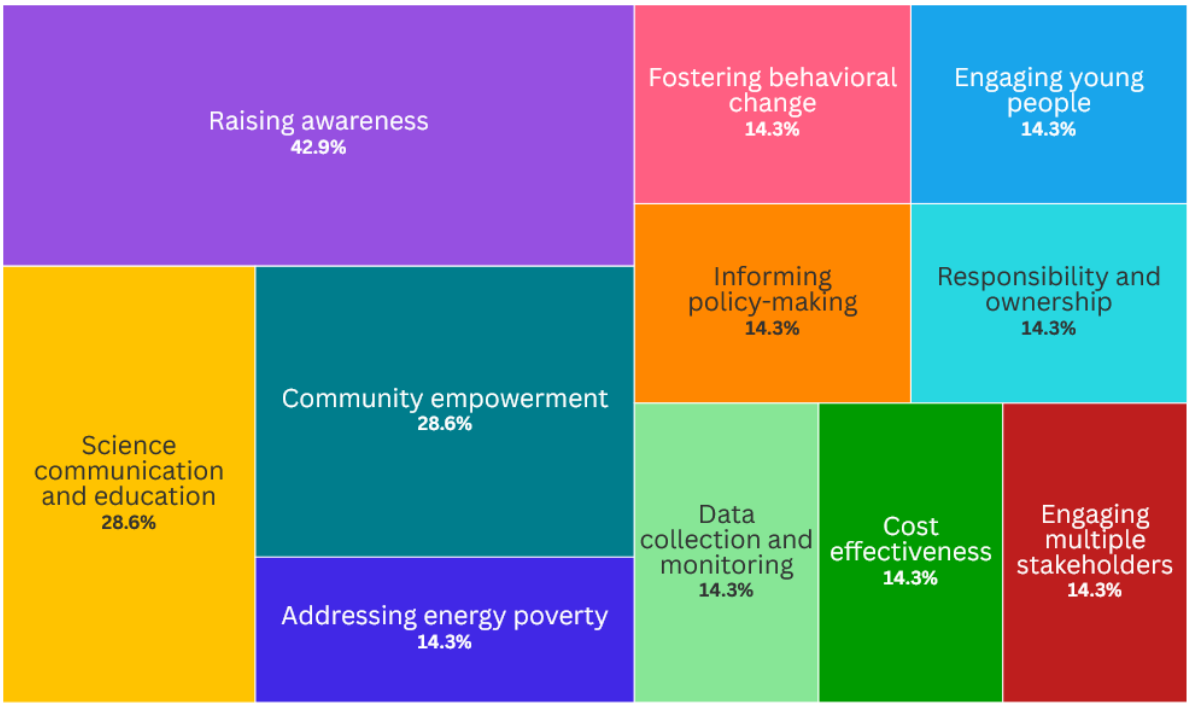

Fig. 7: Opportunities for the application of citizen science in the field of climate change adaptation, as identified through the feedback form completed by participants of the ScienceUs Upscale Academy Bootcamp. Respondents answered the question: "What opportunities do you see for the application of citizen science in the field of climate change adaptation?".

The responses collected through a feedback survey distributed to the projects that participated in the ScienceUs Upscale Academy in Berlin in March 2025 (Figure 7) echo many of the findings described above. The most frequently cited contribution was **raising awareness**, selected by **42.9%** of respondents. This was followed by **science communication and education** and **community empowerment**, each mentioned by **28.6%** of participants.

Other contributions, each identified by **14.3%** of respondents, include **addressing energy poverty**, **fostering behavioral change**, **informing policy-making**, **engaging young people**, **promoting responsibility and ownership**, **supporting data collection and monitoring**, **improving cost effectiveness**, and **engaging multiple stakeholders**.

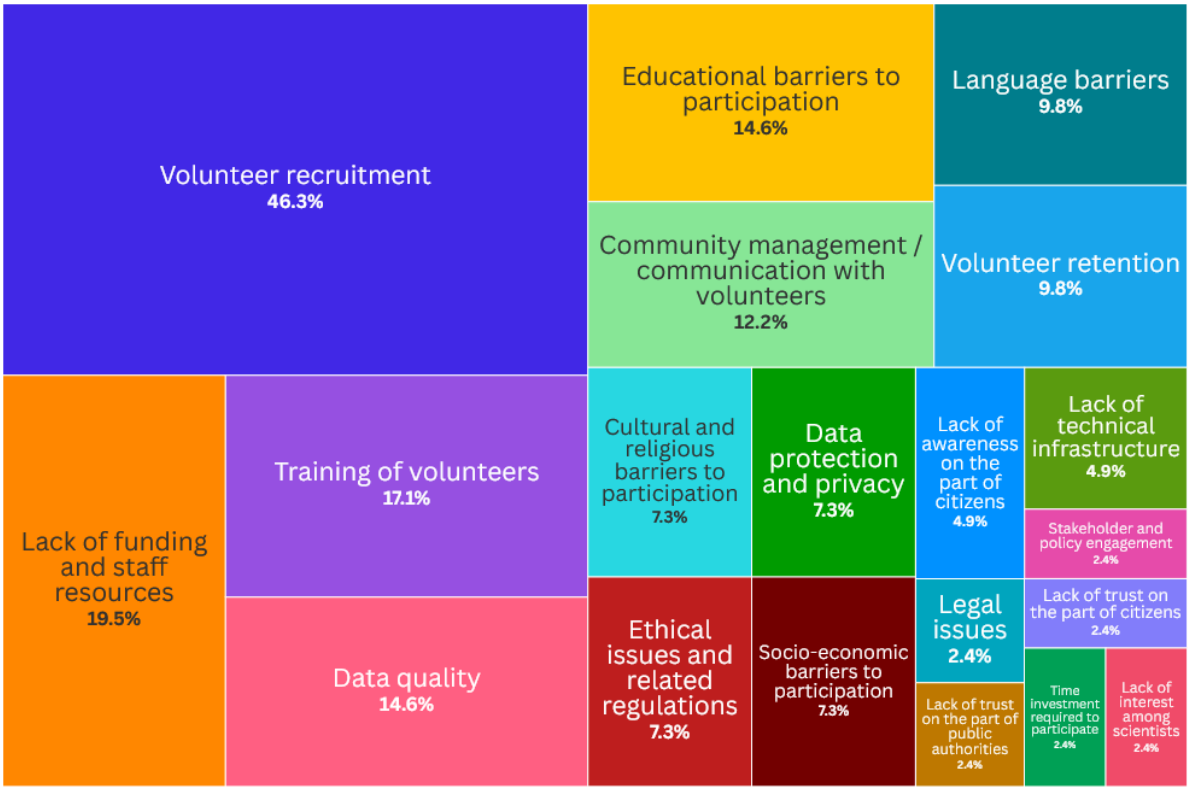

Fig. 8: Responses to the question: "What do you think could be barriers or obstacles to implementing citizen science activities in the context of your project?" by participants in Survey I.

As shown in Figure 8, the most frequently mentioned challenge across the dataset is **volunteer recruitment**, which appears in 46.3% of responses, highlighting it as a central concern in citizen engagement efforts. This is followed by **lack of funding and staff resources**, which is mentioned by 19.5% of the participating projects, underscoring the resource constraints faced by many initiatives. Other commonly cited issues include **training of volunteers** (17.1%), **data quality** and **educational barriers to participation** (14.6% each), and **community management or communication with volunteers** (12.2%).

Several additional challenges were mentioned multiple times, including **language barriers** and **volunteer retention** (9.8%), and **cultural and religious barriers**, **data protection and privacy**, **ethical issues and related regulations**, and **socio-economic barriers to participation** (7.3% each). Less frequently noted but still relevant were issues such as **lack of awareness among**

citizens, **lack of technical infrastructure** (4.9% each), and several single-mention concerns, including **stakeholder and policy engagement**, **legal issues**, **public trust and support**, **time investment requirements**, and **lack of interest among scientists**.

The analysis of recurring topics reveals several broad themes that highlight the concerns expressed by individuals and organizations **not yet using citizen science in their projects**. These insights provide a valuable glimpse into the perceived barriers that may be preventing wider adoption of participatory approaches.

The most prominent concern centers on **volunteer management**. *Volunteer recruitment* stands out as the most frequently mentioned issue, indicating that many potential adopters worry about whether they can attract sufficient public participation. Related concerns include *training of volunteers*, *volunteer retention*, *community management or communication with volunteers*, and *cultural and religious barriers to participation*. These reflect broader apprehensions about the capacity to effectively support and sustain a diverse community of citizen scientists, ensure long-term engagement, and handle differences in worldview or cultural background.

A second major theme involves **resource constraints**. The *lack of funding and staff resources* was cited as a core limitation that could hinder the launch or scalability of citizen science initiatives. *Lack of technical infrastructure* was also mentioned, pointing to material and logistical barriers that some organizations anticipate.

Equally pressing are **barriers to participation** — challenges that could limit citizen involvement from the outset. These include *educational*, *linguistic*, *socio-economic*, and *cultural barriers*, as well as the *time commitment required* and a *lack of awareness among citizens*. Such concerns suggest that many potential practitioners are wary of unintentionally excluding certain groups or facing low engagement due to these underlying issues.

Another significant theme involves **data and digital challenges**. Potential adopters cited *data quality*, *data protection and privacy*, and a *lack of ICT skills or infrastructure* as key risks. These concerns reflect apprehensions about whether citizen-generated data can meet scientific standards and whether participants' personal information can be managed responsibly.

Concerns about **trust, ethics, and policy alignment** are also reflected in responses to this question. Topics such as *ethical and legal issues*, *lack of trust from public authorities*, and *distrust among citizens* highlight the perceived institutional and reputational risks associated with citizen science. The mention of *stakeholder and policy engagement* further underscores worries about how such projects might fit within existing policy frameworks or gain institutional backing.

Lastly, a less prominently voiced concern points to a **lack of engagement from the scientific community itself**. The *lack of interest among scientists* suggests that some are hesitant to adopt

citizen science because they doubt its relevance or influence within the conventional research system.

Altogether, these themes offer important insights into the range of perceived challenges that may be holding individuals and organizations back from engaging with citizen science. Addressing these concerns through targeted support, inclusive design, and institutional buy-in could be key to expanding participation and unlocking the full potential of citizen-driven research.

These perceived challenges and obstacles are also reflected in responses to the question “In which of the following areas would you appreciate some support or guidance to help you plan and implement citizen science activities?”

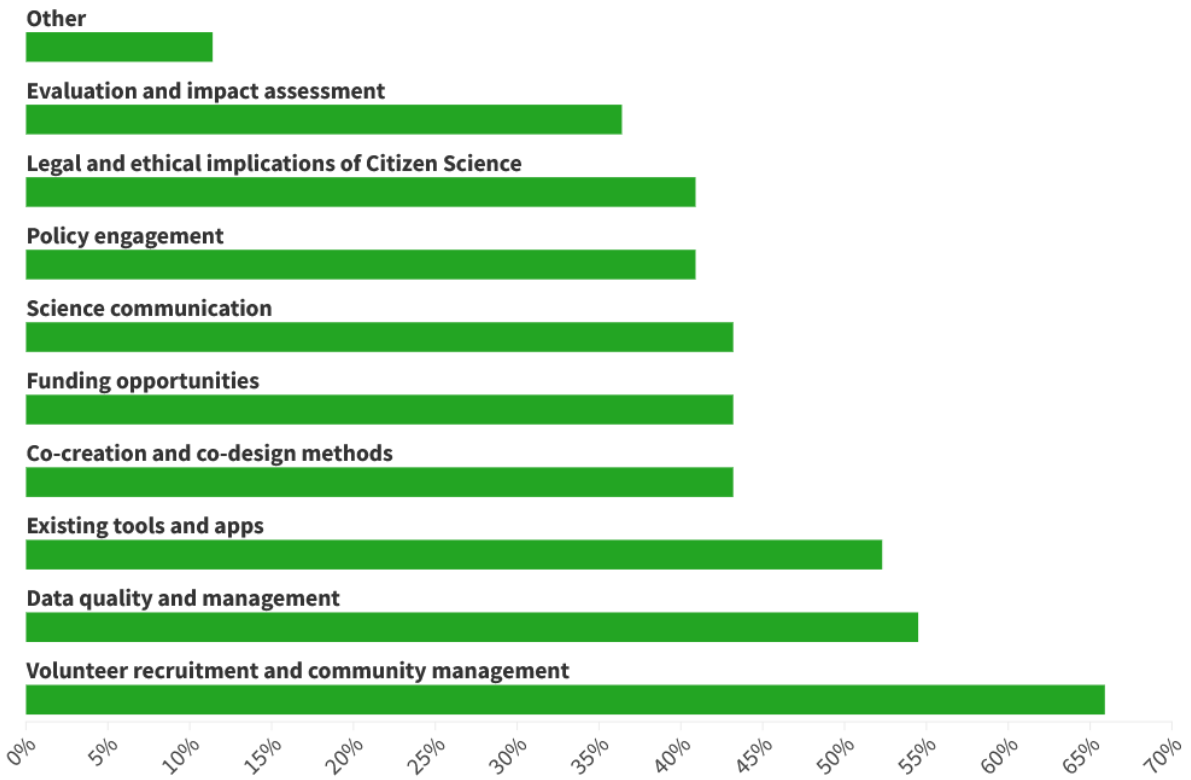

Fig. 9: Responses to the question: "In which of the following areas would you appreciate some support or guidance to help you plan and implement citizen science activities?" as answered by participants in Survey I.

The second item in this section of Survey I was a multiple-choice question. Respondents were asked to indicate the areas in which they would appreciate support or guidance when planning and implementing citizen science activities. As shown in figure 9, the most frequently selected area was **volunteer recruitment and community management**, cited by 65.9% of respondents. This was followed by **data quality and management** (54.5%) and **existing tools and apps** (52.3%). Several other areas were identified by over 40% of participants, including **science communication** (43.2%), **funding opportunities** (43.2%), **co-creation and co-design methods** (43.2%), **legal and ethical implications of citizen science** (40.9%), and **policy engagement** (40.9%). **Evaluation and impact assessment** was selected by 36.4%, while only 11.4% of respondents indicated **other** areas of interest.

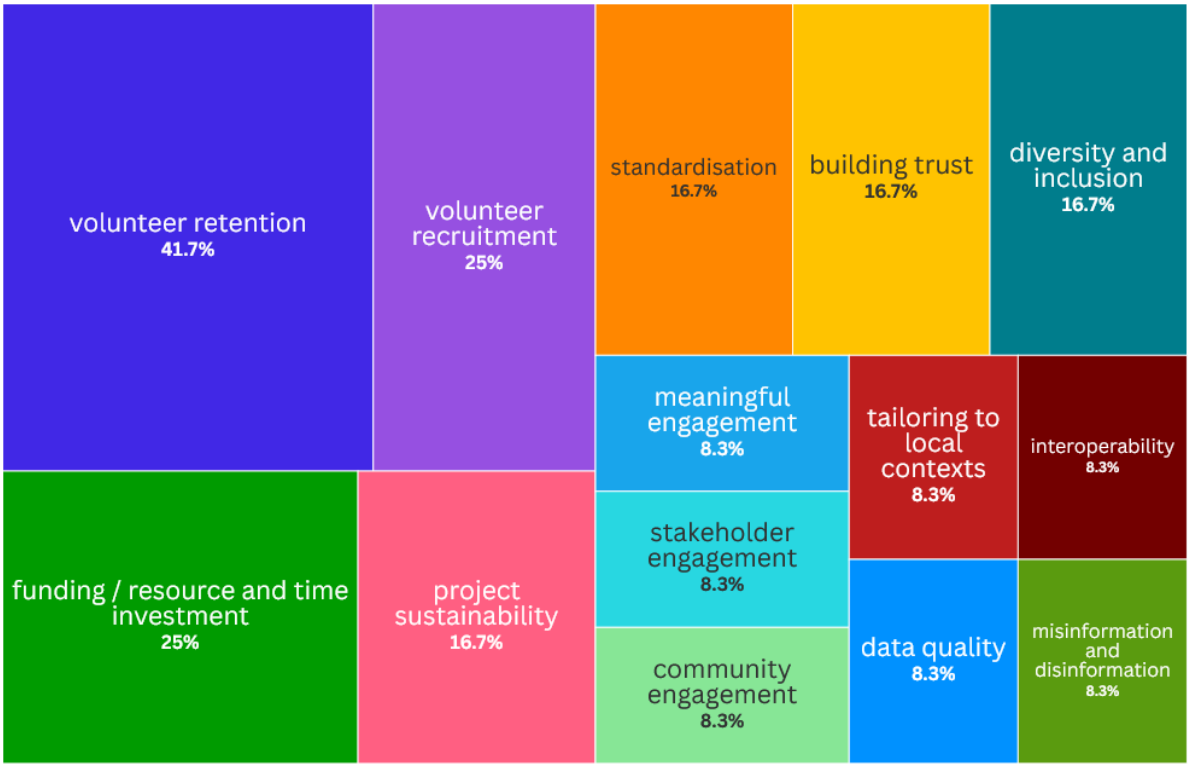

Fig. 10: Challenges for the application of citizen science in the field of climate change adaptation, as identified by participants in Survey II. Respondents answered the question: "What challenges do you see for the application of citizen science in the field of climate change adaptation?".

Figure 10 showcases a range of recurring challenges and obstacles from the responses of Survey II. Among these, **engagement and participation** emerged as the most frequently cited area of difficulty. *Volunteer retention* was particularly prominent, mentioned in 41.7% of responses, reflecting widespread concern over sustaining citizen engagement across the

lifecycle of projects. *Volunteer recruitment* was also commonly noted, appearing in 25% of responses, which points to the ongoing challenge of mobilizing community support. Other related concerns included *meaningful engagement*, *stakeholder engagement*, and *community engagement*, which, although mentioned less frequently, underscore the importance of ensuring that the intended target audiences are reached and engaged in an impactful manner.

Closely tied to these issues are challenges related to **trust and inclusion**. *Building trust* was identified as a critical obstacle (16.7%), highlighting the fragility of social cohesion in participatory processes. Similarly, diversity and *inclusion* was recognized as a key area where projects often struggle, particularly when trying to engage underrepresented or marginalized groups.

Concerns around the **long-term viability and resourcing** of projects were also evident. *Funding / resource or time investment* was mentioned in 25.0% of responses, alongside *project sustainability* (16.7%), suggesting that many citizen science initiatives face barriers in maintaining momentum and securing the support needed to continue their work effectively over time.

In terms of technical and operational challenges, issues such as *standardisation*, *interoperability*, and *data quality* were raised. These point to the infrastructural and procedural complexities involved in managing data and ensuring that project outputs are reliable, compatible, and scalable.

Another critical concern identified was the **need to tailor approaches to local contexts**, highlighting the importance of flexibility and contextual sensitivity in citizen science approaches. Solutions that fail to account for the specific needs and characteristics of a given community are often less effective or poorly received.

Finally, the challenge of **misinformation and disinformation** was noted, pointing to the broader societal risks that can undermine both the credibility and the impact of citizen science efforts in the climate adaptation space.

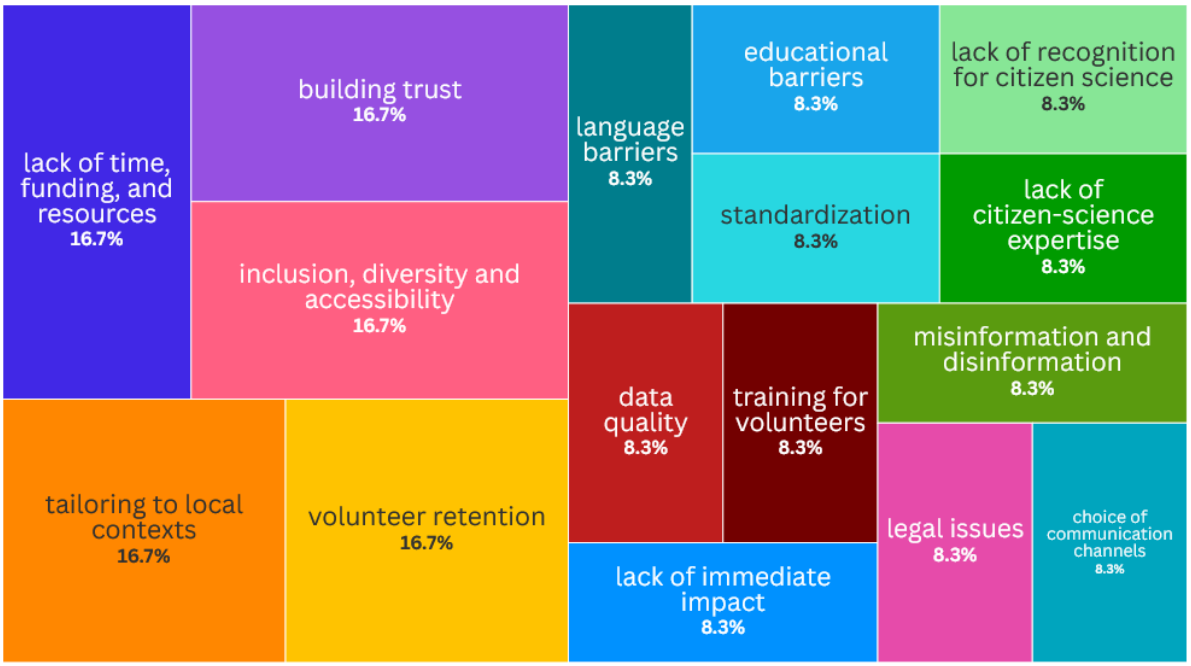

Fig. 11: Challenges and obstacles to implementing citizen science, as experienced or anticipated by participants in Survey II. Respondents answered the question: "What challenges/obstacles to implementing citizen science in your project have you experienced or do you expect to experience?".

The citizen science projects working on climate change adaptation who participated in our second online survey have encountered several practical and structural challenges that could potentially limit their impact and sustainability (Figure 11). One of the most consistently reported themes relates to the **demand for time and resources**. Respondents emphasized that citizen science activities require considerable investments in terms of budget and staff resources, highlighting the need for dedicated and sustained funding and institutional support for such initiatives.

Another prominent area of concern is **trust**, highlighting the delicate social dynamics at play in collaborative science efforts. Similarly, challenges related to **inclusion and accessibility** emerged multiple times, pointing to the need for more thoughtful and equitable participation. This included not only broad notions of inclusivity and user-friendliness but also specific issues such as *language barriers* and *educational barriers*, which were each identified as separate, critical factors limiting participation from certain communities.

Maintaining engagement remains a persistent issue, with *volunteer retention* mentioned as a specific pain point. This underscores the difficulty of ensuring long-term involvement from participants, even when initial recruitment efforts are successful.

Projects also reported challenges related to **context sensitivity**, with *tailoring to local contexts* noted as a recurring obstacle. This suggests that one-size-fits-all approaches often fail to resonate or be effective across different communities.

In the realm of **knowledge and technical capacity**, several important gaps were highlighted. These include the *lack of standardization*, *data quality issues*, and a *lack of expertise in citizen science*. Additionally, the *need for volunteer training* was cited as a barrier to ensuring quality and consistency in project outcomes.

Projects also identified difficulties in achieving visible results, with a *lack of immediate impact* listed as a concern. This connects to a broader communication challenge, where *choice of communication channels* and the *accessibility of information* were noted as areas needing improvement.

Finally, wider societal and legal challenges also came into play. *Misinformation and disinformation* were mentioned as disruptive forces that can undermine trust and credibility, while *legal issues* added another layer of complexity to citizen-led climate adaptation work.

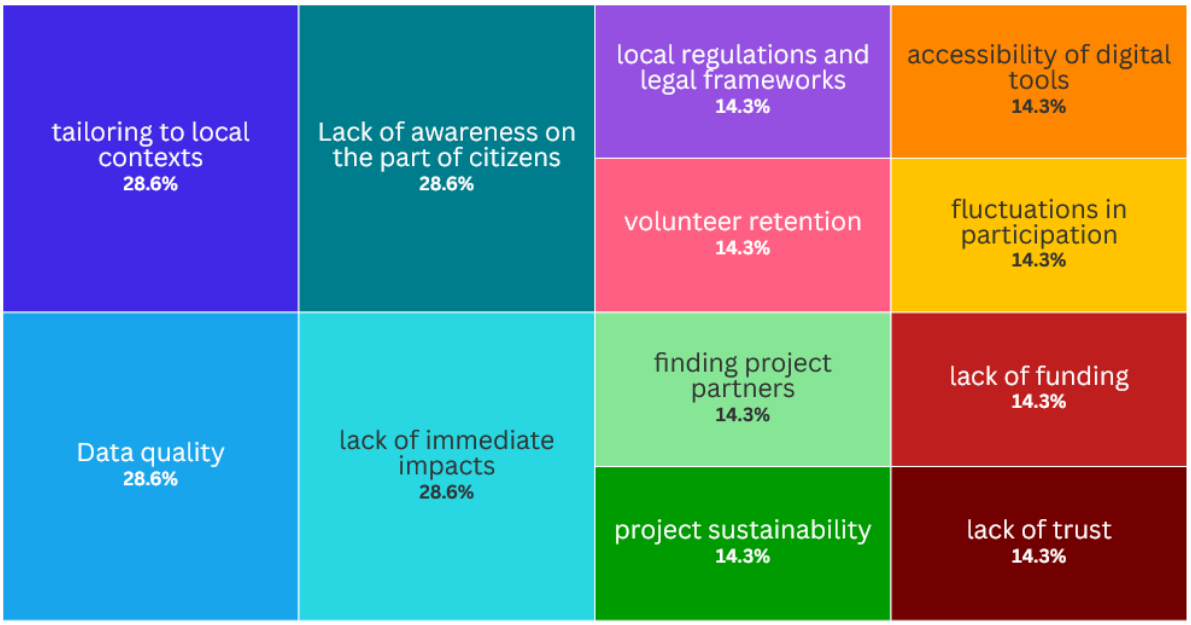

Fig. 12: Challenges and obstacles as identified through the feedback form completed by participants of the ScienceUs Upscale Academy Bootcamp. Respondents answered the question: "What challenges do you see for the application of citizen science in the field of climate change adaptation?".

The feedback survey results (Figure 12), highlight several key challenges faced by projects participating in the ScienceUs Upscale Academy. Among the most frequently mentioned challenges, each cited by **28.6%** of respondents, are **tailoring activities to local contexts**, **lack of awareness on the part of citizens**, **data quality issues**, and the **lack of immediate impacts** from citizen science initiatives.

Other challenges, each noted by **14.3%** of participants, include navigating **local regulations and legal frameworks**, ensuring **volunteer retention**, improving the **accessibility of digital tools**, managing **fluctuations in participation**, **finding suitable project partners**, ensuring **project sustainability**, addressing **lack of funding**, and overcoming **lack of trust**.

A) Opportunities and added value of CS in the context of CCA				
Question 1				
Rank	Survey I (open-ended)	%	Survey 2 (open-ended)	%
1	Environmental monitoring	29.7%	Data collection and monitoring	33.3%
2	Science communication, education and awareness Developing mitigation and adaptation strategies Natural disasters and risk management Biodiversity	16.2%	Building resilience Community engagement	25.0%
3	Food and agriculture Survey / social science research	13.5%	Community and collective action Building trust Science-policy interface Nature-based solutions Raising awareness	16.7%

			shared identity / responsibility	
4	Implementing mitigation and adaptation measures Public health Urban planning Sustainable mobility Evaluating adaptation and mitigation measures Needs assessment	8.1%	behavioural change community empowerment evaluating adaptation and mitigation measures developing solutions social cohesion systemic change	8.3%
5	Ecosystem restoration Waste management Developing and testing tools and technologies Nature-based Solutions	5.4%		
Question 2				
Rank	Survey I (multiple-choice)	%	Survey 2 (open-ended)	%
1	By helping you raise awareness and educate citizens	77.3%	Closing data gaps	41.7%
2	By helping you collect data	75.0%	Tailored (local) solutions and strategies	33.3%
3	By helping you co-create climate adaptation strategies	68.2%	Raising awareness	25.0%
4	By helping you foster behavioral change	63.6%	Science communication and education Increasing resilience Empowerment and ownership Interdisciplinarity / new perspectives	16.7%
5	By helping you test strategies and technologies	54.5%	Nature-based solutions Integrating local and experiential knowledge Cost efficiency Informing policy Increasing legitimacy and uptake of policy	8.3%

Table 2a. Juxtaposition of responses from Survey I and Survey II regarding opportunities and added value of citizen science for climate change adaptation. Responses to the second question in Survey I are based on predefined multiple-choice options, while all Survey II results were derived through thematic coding of open-ended answers. Percentages reflect frequency within each survey, but direct comparison between surveys should be interpreted cautiously.

B) Challenges and barriers for CS in the context of CCA				
Question 1				
Rank	Survey I (open-ended)	%	Survey II (open-ended)	%
1	Volunteer recruitment	46.3%	Volunteer retention	41.7%
2	Lack of funding and staff resources	19.5%	Volunteer recruitment Funding / resource and time investment	25.0%
3	Training of volunteers	17.1%	Project sustainability Standardisation Building trust Diversity and inclusion	16.7%
4	Educational barriers to participation Data quality	14.6%	Meaningful engagement Stakeholder engagement Community engagement Tailoring to local contexts Interoperability Data quality Misinformation and disinformation	8.3%
5	Community management / communication with volunteers	12.2%		
Question 2				
Rank	Survey I (multiple-choice)	%	Survey 2 (open-ended)	%
1	Volunteer recruitment and community management	65.9%	Lack of time, funding, and resources Building trust Inclusion, diversity and accessibility Tailoring to local contexts	16.7%

			Volunteer retention	
2	Data quality and management	54.5%	Language barriers Educational barriers Standardization Lack of recognition for citizen science Lack of citizen-science expertise Data quality Training for volunteers Lack of immediate impact Misinformation and disinformation Legal issues Choice of communication channels	8.3%
3	Existing tools and apps	52.3%		
4	Science communication Funding opportunities Co-creation and co-design methods	43.2%		
5	Policy engagement Legal and ethical implications of citizen science	40.9%		

Table 2b.: Comparative overview of challenges and barriers identified in Survey I and Survey II concerning the application of citizen science in climate change adaptation. Responses to the second question in Survey I are based on predefined multiple-choice options, while all Survey II results were derived through thematic coding of open-ended answers. Recurring themes across both datasets highlight operational challenges related to volunteer engagement, funding constraints, and data quality management.

Semi-structured Interviews

The three semi-structured interviews conducted with the IDalert, Adaptation Agora, and Precilience projects offered an opportunity to explore survey responses in greater depth through follow-up questions. All three projects acknowledged the added value that citizen science brought to their respective initiatives.

The interview with IDalert highlighted the extent to which the project relies on citizen science for data collection and the cost effectiveness of collecting data in this way:

"We use citizen science to monitor the geographic expansion of these ticks and the introduction and even the potential establishment of this type of tick . So citizen science is a very cost effective way of doing these types of surveys."

In the conversation with Adaptation Agora, the necessity of involving local communities in the development and design of adaptation strategies was emphasised:

"*Adaptation can be done only if you have a strong community because you have to make the right decision for them and then they need to be engaged. For example, if you replace a parking spot with a green area, the community needs to understand the reason*".

Furthermore, the benefit of involving local institutions, who already interact with citizens on a daily basis and therefore have a good understanding of the wider context, was recognised.

Co-benefits from citizen science initiatives, such as data collection, were acknowledged as playing an important role in strengthening the sense of community through increased awareness and engagement of citizens:

"*Collecting data can be useful also to improve their awareness and I hope after the awareness there is action, because if they are aware of what is happening, perhaps they will also be more prone to make decisions (e.g. reducing their water use)...*"

For the Precilience project, citizen science serves as a vital data source and creates a reciprocal process, where information flows both ways between citizens and project partners. This dynamic allows knowledge to spread more broadly within the community, reaching networks such as friends, family, and others.

When asked to consider the broader benefits of citizen science beyond their own projects, participants highlighted tangible outcomes, such as reduced exposure to tropical pathogens, along with co-benefits like increased engagement and heightened awareness of environmental issues, which can lead to more informed decision-making. The potential impact of these outcomes at the policy and political levels was also emphasized:

"Hopefully that will then also strengthen the policy engagement with the public around environmental issues. In Germany, we have seen this backlash from the AfD against the Green Deal. Same thing is obviously true in Holland and in France. And so maybe these types of initiatives can potentially counterbalance that push back to this kind of populist opposition to climate change…" (IDAlert).

The importance of working with and engaging the local communities to understand their vulnerabilities was emphasised by the Adaptation Agora Project:

"It would be very useful for prioritizing actions to know where vulnerable people are located, to collect data from them, and to identify the most critical parts of the community…" .

Additionally, the value of collecting a broad spectrum of data was emphasized, including information about the citizens themselves (such as education, health, age, etc.), as this can support the development of adaptation strategies tailored to local contexts.

Regarding challenges, the IDalert project highlighted the difficulty of maintaining engagement. They noted that while initial interest in their tick identification project was high, participation quickly declined. This, they believe, is partly due to the overwhelming amount of information citizens are exposed to, especially through social media, causing such initiatives to quickly fade into the background:

"...in Sweden for the Tick app, we had something like 26,000 people that signed up and then within a year just trickled down to 4000 or something like that..." (IDalert).

The issue of data quality and data sharing was also raised. Adaptation Agora discussed the challenge of accessing data when local institutions collect it but fail to share it with their communities. Meanwhile, IDalert highlighted concerns about the quality of citizen-collected data being questioned by external parties, stressing that, in their case, using citizen-collected data was not a matter of choice but the only viable option:

"...people definitely doubt the data... but what's my choice, right? Like no data or citizen science data, right? Like to me, that's a no brainer, right? And in fact, we never really use the citizen science data at face value. There is always an evaluation step where..."

Both Adaptation Agora and Precilience addressed the challenge of resource intensity (time and workload) involved in tailoring citizen science initiatives to local contexts. This includes tasks such as designing new protocols and surveys for each community or translating questions into local languages and dialects—such as in the case of the Precilience Project, which conducts surveys with local forestry workers:

"...each of them are done in their own language and then they are transferred to English and analysed altogether. So it's quite intensive work to do and quite a heavy workload..." (Precilience).

Finally, Precilience communicated the difficulty of meeting expectations that solutions can be delivered immediately, when in reality they often take multiple years:

"*...The problem is that they also sometimes demand that the option will be ready immediately and maybe lacking the understanding that it could take five years, 10 years…*" (Precilience).

CS Project	Role of citizen science	Perceived Benefits	Challenges Identified
IDAlert	Cost-effective data collection on the spread of ticks.	• Low-cost monitoring • Increased public awareness • Policy influence potential • Only viable data source	• Declining participant engagement • Data quality concerns • External skepticism of citizen-generated data
Adaptation Agora	Engaging local communities in adaptation planning and decision-making.	• Enhanced community engagement • Local institutions as facilitators • Broader socio-demographic data	• Difficulty accessing data from local institutions • High resource demand for local adaptation • Need for local trust
Precilience	Reciprocal information exchange between citizens and project partners.	• Community empowerment • Knowledge sharing • Raised environmental awareness	• High workload for local adaptation (e.g., translations) • Unrealistic expectations for immediate results

Table 3: Summary of Key Insights from Semi-Structured Interviews with IDAlert, Adaptation Agora, and Precilience Projects

Discussion

The aim of this deliverable is to explore the opportunities and challenges associated with integrating citizen science into climate change adaptation efforts within the framework of EU-funded projects, specifically in the context of the EU Mission "Adaptation to Climate Change." As part of the ScienceUs project, which aims to strengthen the role of citizen science in climate change adaptation efforts across Europe, this deliverable contributes to a better

understanding of how participatory research can support the objectives of the New European Research Area (ERA) and promote climate resilience at regional and local levels.

Based on a triangulated research approach—combining a literature review, two targeted surveys, a feedback form and semi-structured interviews—this study provides an overview of the current landscape of citizen science in the field of climate adaptation in Europe. It reflects the perspectives of projects that have already applied citizen science methods, as well as those considering future integration. The results offer insights into the motivations, perceived benefits, and practical barriers experienced by practitioners.

The findings contribute to the wider discourse on participatory approaches in research and policy, highlighting how citizen science can help close critical gaps in data collection, resource allocation, and stakeholder engagement. This discussion situates the empirical findings within existing scientific and policy contexts and outlines possible directions for future action in both research and policy development, highlighting both the potential and limitations of citizen science approaches in current EU-funded adaptation initiatives.

First of all, the results of the first survey we conducted confirm that there is **considerable untapped potential for citizen science** in the context of the EU's adaptation efforts - they indicate a strong interest among Horizon Europe projects that are not currently incorporating citizen science to involve it in their future activities.

Many of the responses from both surveys, interviews and feedback form in regard to the potential applications and benefits of citizen science in the context of climate change adaptation highlight opportunities to address challenges related to the objectives of the EU Mission "Adaptation to Climate Change" identified in the literature review. In the first survey, environmental monitoring was cited most frequently, followed by biodiversity and natural disaster and risk management. Responses from the second survey, which was targeted at projects that already implement citizen science, similarly highlight data collection and monitoring as key contributions of citizen science to the climate adaptation landscape.

Engaging citizens in the monitoring of environmental parameters (e.g. temperature, water quality, air pollution etc.) can constitute a sustainable solution for collecting environmental data over time and from areas previously not reached - which addresses challenges such as **closing data gaps** in time and space (Hecker et al. 2018; Cohn 2008 and Hu et al. 2025) and improving efficiency of data collection (Christine and Thinyane, 2021). Furthermore, employing citizen science in this way can help **reduce staff effort and overall costs**. After all, citizen science projects rely on volunteer participation and tend to use low-cost monitoring equipment (Perez et al., 2023), thereby addressing the challenge of limited financing, personnel, and resources for climate adaptation in the EU. Finally, closing data gaps in environmental monitoring through citizen science can also help **improve natural disaster and risk management**—for example by feeding data into early flood warnings systems (Alemu et al.

2023). A co-benefit of this approach is that it raises community awareness of such phenomena, which can lead to greater public engagement and further action, creating positive feedback loops.

Another benefit or added value of citizen science frequently cited in response to both surveys and in our semi-structured interviews is the participatory development of adaptation and mitigation strategies that integrate the experiences, interests and concerns of local residents. By working with local communities, specific vulnerabilities and needs can be identified and context-specific resilience strategies that are driven by local knowledge and priorities can be created. This also resonates with the results of our literature review, which highlighted the importance of **locally tailored adaptation strategies** in effectively dealing with the repercussions of climate change (Cruz et al. 2025; Duerden, 2004; Moser and Pike 2015). As Granderson emphasizes, climate change impacts are felt most frequently at the community level (Granderson, 2014). At the same time, local and regional variability in the EU means that a "one size fits all" approach is doomed to fail. Through citizen science, citizens can become active decision-makers and co-creators of solutions in their own neighborhood, town or region (Hügel, and Davies, 2020).

The co-design of local adaptation strategies by means of citizen science initiatives is also closely related to another challenge identified in our literature review - namely supporting the integration of local and regional level governments in EU policy by increasing the contribution of communities to EU policy-making (Hadj-Hammou et al, 2017). Respondents in Survey II specifically mentioned **strengthening the science-policy** interface as one benefit of citizen science, while Survey I revealed several thematic areas in which citizen science can potentially **i**nform policy decisions—such as public health, urban planning and sustainable mobility.

A particular advantage of citizen science reflected in responses to Survey II is that, by actively involving citizens in collecting data and developing strategies and solutions, it can help **build trust in science, empower communities, and create a sense of ownership and shared responsibility,** thereby contributing to social cohesion and increasing the legitimacy and uptake of policy. In this context, a comparison of the results of Survey I and Survey II suggests slight differences in perception between projects that are already using citizen science and those that are not. While both groups cited **science communication, education and awareness-raising** as valuable citizen science contributions to climate change adaptation, respondents of Survey II (those already using citizen science) additionally emphasized aspects related to collaboration, empowerment and joint responsibility. The responses from the ScienceUs Bootcamp Feedback broadly align with those from the two surveys - highlighting the opportunity for citizen science to increase awareness, empower community and strengthen science communication and education.

Overall, while the first survey highlights the broad potential of citizen science, the second survey offers a more grounded perspective, presenting citizen science as a valuable contributor to adaptation strategies and solutions, rather than as a standalone solution. This may reflect a shift from theoretical potential to more practice-oriented experiences among projects that have already engaged with citizen science. However, what also emerges from both the survey responses and the semi structured interviews is that the involvement of citizen science can produce co-benefits that can aid adaptation efforts over the longer term. These co-benefits include fostering heightened public awareness, strengthening civic engagement, and cultivating more resilient communities, thereby enhancing the societal capacity to respond proactively to climate-related risks. Such outcomes align with the objectives of the EU Mission 'Adaptation to Climate Change', particularly in promoting inclusive and participatory governance. While for many initiatives these co-benefits represent an important complement to adaptation strategies, in certain projects, citizen science constitutes the principal data source and methodological approach. This is exemplified by the IDAlert project which relies on citizen-generated data to monitor and assess the spread of tick-borne diseases as a core component of its research and intervention strategy. This potential dual role of citizen science—as both a catalyst for social resilience and a primary means of data acquisition—highlights its versatility within diverse adaptation contexts (Paul et al. 2018).

In light of all these potential benefits and the strong interest in citizen science reflected particularly in Survey I, the question arises why many projects have not yet adopted participatory approaches. Insights from our datasets, capturing both the anticipated and actual challenges faced by projects employing citizen science in the context of climate change adaptation, can offer valuable answers to help explain this implementation gap.

The main barrier identified in Survey I was **volunteer recruitment**, followed by **volunteer training** and **lack of funding/resources**. A lack of funding and resources often results in limited project sustainability—another issue which featured prominently in responses to Survey II and can negatively affect scientific and policy-related outcomes as well as community engagement and trust. These recurring themes clearly align with two challenges identified in the literature review, low citizen participation (Cruz et al. 2025) and institutional and financial barriers, and suggest that practical constraints, rather than conceptual doubts about the value of citizen science, are the primary impediments to its wider adoption. The challenge of maintaining long-term engagement was mentioned less frequently in the responses from Survey 1, despite being commonly cited in the literature. This discrepancy may be due to the fact that successful volunteer recruitment is a fundamental prerequisite for sustaining any form of engagement—making it possible that respondents focused more on this initial step, resulting in fewer separate mentions of long-term engagement. It is also possible that long-term engagement challenges only become fully apparent after initial recruitment has been achieved, highlighting a phased progression in the barriers encountered.

In our second survey, issues related to **sustaining volunteer engagement and participation** were cited most frequently, which aligns with the findings of the literature review that sustained engagement is the product of a complex interplay of intrinsic, external and collectivistic factors (Delfine et al. 2024, Geiger et al. 2022) and that a diverse range of incentive methods are needed to sustain it (Tinati et al. 2015, Moghaddam et al. 2023). As noted in the previous section, this emphasis on ongoing engagement rather than initial recruitment is expected, given that these projects are already implementing citizen science and have likely addressed initial recruitment hurdles to some degree. The results of Survey II furthermore indicate that **ensuring accessibility, inclusion** and successful engagement of participants with diverse language skills and educational backgrounds can be particularly challenging.

In contrast to the literature, however, specific challenges such as effective communication strategies or addressing the psychological dimensions of the climate crisis (Geiger et al. 2022; Truelove et al. 2015), were not explicitly mentioned. This discrepancy suggests that these aspects may be under-recognized in practice and could therefore represent important focal points for the development of targeted support measures, including capacity-building and training programmes designed to enhance long-term participation and community resilience. Addressing these gaps through structured training on science communication and engagement strategies could further strengthen the effectiveness and inclusivity of citizen science initiatives in the context of climate adaptation. Within the framework of ScienceUs, such capacity-building measures—delivered through the ScienceUs Upscale Academy— could offer a valuable opportunity to equip project teams with the necessary tools to foster sustained engagement, enhance community involvement, and ultimately contribute to the broader objectives of the EU Mission 'Adaptation to Climate Change'.

Additional concerns that emerged in the second survey and the responses in the feedback form —conducted among projects already implementing citizen science— include challenges related to the **standardization and interoperability of data and methods**, as well as the need to adapt approaches to specific local contexts. These challenges, which were not raised in the first survey, were also highlighted during the semi-structured interviews, where participants noted that tailoring methods and protocols to different communities often makes processes more time-consuming and resource-intensive, as one-size-fits-all solutions are rarely applicable. At the same time, interviewees stressed that **tailoring citizen science approaches to specific local contexts** and ensuring community involvement is essential for the long-term success of adaptation strategies. The higher frequency of these challenges in the second survey likely reflects the fact that they tend to arise only *after* citizen science has been implemented, often as part of a 'learning by doing' process or during efforts to scale up citizen science activities within projects. Interestingly, concerns about data quality were not quite as prominent in our results (particularly in responses to Survey II) as they are in the literature (Lukyanenko et al., 2019).

Instead, interviewees emphasized the value of gaining access to otherwise inaccessible data sources, as highlighted in the interview with IDalert.

These insights from our research highlight the critical role of ScienceUs in fostering mutual learning and co-development among the projects participating in its framework. Specifically, facilitating structured exchanges between projects selected for further support and those not selected is essential to support reflection, experience-sharing, and collaborative problem-solving. Such a community of practice enables project initiators not only to develop shared standards and good practices, but also to contextualize their individual experiences within a broader landscape of participatory climate adaptation. The internal networking of ScienceUs will hopefully strengthen the collective capacity of the ScienceUs projects and underlines that community-building is equally vital among project leaders, as it is among citizen participants.

When comparing the responses from both surveys in regards to expected and actual encountered challenges, it is once again notable that, whereas the first surveys indicates a prevailing “deficit model” perspective, wherein citizen engagement is perceived to require significant investment in public awareness, science communication, and volunteer recruitment and training, the second survey reveals a notable shift in approach—reflecting a more collaborative model based on shared responsibility and mutual learning between citizens, scientists, and policymakers. This evolution in mindset aligns with contemporary policy frameworks that emphasize co-production of knowledge and inclusive governance in climate change adaptation.

To sum up, what clearly emerges from the literature review and the survey data is that citizen science has the potential to contribute towards tackling many of the key challenges specific to the EU´s adaptation to climate change mission. In particular citizen science can contribute to closing critical data gaps by enabling lower cost, long-term environmental monitoring and increasing community engagement and societal resilience - both of which are essential prerequisites for the successful implementation of adaptation responses. The number and range of opportunities and added value of citizen science highlights the co-benefits that can arise from involving citizens and the potential creation of positive feedback loops in which ultimately, community resilience is strengthened. The recognition that adaptation strategies need to be locally tailored to ensure their effectiveness further highlights the immense value that the involvement of citizens can have in their development. Moreover, these contributions align with the Mission’s objectives of promoting smarter, more systemic adaptation measures. Initiatives such as ScienceUs are essential to systematically support and scale these efforts, enabling citizen science to become an integral part of climate adaptation. Sustained funding for coordination and support actions like ScienceUs is therefore crucial to unlock the full potential of citizen science and embed it within long-term adaptation strategies.

However, the frequently cited challenge of volunteer recruitment remains a significant barrier to the wider adoption of citizen science in climate adaptation projects. Concerns about insufficient participation and lack of funding (and thus project sustainability) can limit the scalability of citizen science initiatives and potentially undermine their impact. Addressing this issue is thus essential to ensure the long-term viability and effectiveness of citizen-driven adaptation efforts. Coordination and support actions such as ScienceUs can play a key role in helping projects develop effective strategies for outreach, engagement, and sustained participation.

Conclusion and Recommendations

Based on the findings of this report, the following recommendations are proposed to enhance the role of citizen science in supporting climate adaptation efforts within the EU Mission framework.

1. Develop and implement targeted communication strategies grounded in behavioral insights and psychological research to raise public awareness of citizen science opportunities, and to enhance participation and volunteer recruitment.

2. Recognize and promote the importance of locally tailored adaptation strategies, as one-size-fits-all approaches are insufficient to meet the diverse needs of communities across the EU.

3. Improve data accessibility and sharing by encouraging open access to results, thereby strengthening the science-policy-community interface and fostering sustained citizen engagement.

4. Support structured knowledge exchange between research projects that use citizen science and those that do not through platforms or funding schemes that enable the sharing of best practices and lessons learned, in order to clear up misconceptions and explore potential synergies and collaboration.

5. Acknowledge and communicate the co-benefits of citizen science—such as enhanced environmental literacy, social cohesion, and local ownership—as key contributions to the EU's long-term climate adaptation goals.

6. Integrate citizen science as a strategic, complementary tool that strengthens broader adaptation policies and interventions.

7. Engage and empower local authorities by providing incentives, targeted funding, and institutional support to scale up citizen science initiatives, thereby reinforcing local resilience and community-led adaptation efforts.

8. Allocate adequate funding and resources to allow for meaningful engagement and maximise scientific and policy impact.

Implementing these recommendations will contribute to a more inclusive, data-informed, and resilient approach to climate adaptation across Europe.

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