Report for the UNESCO Open Science Toolkit

Guidance

for the implementation of the UNESCO Open Science Recommendation

re. "Opening science to society"

Contents

1 - Introduction

The UNESCO Recommendation on Open Science was endorsed in November 2021 by all 193 member states of UNESCO after two years of preparation. The recommendation is extensive and supports many aspects of opening scientific practice, such as requiring scientists to publish their results as open access and the need for an infrastructure to support the sharing of data. The four pillars of the Recommendation are i) open scientific knowledge, ii) open science infrastructures, iii) open dialogue with other knowledge systems, and iv) open engagement of societal actors. The importance of opening science to society is particularly highlighted in pillars iii and iv, nevertheless, UNESCO is aware that a number of countries are unsure about how to progress their journey of opening science to society and engaging science with societal actors.

Citizen science practitioners across the globe have extensive and diverse first-hand experience with the practice of engaging different groups of stakeholders in the scientific production and application of new knowledge. Under the umbrella of the Community of Practice on Citizen Science and Open Science (CS&OS CoP) of the Citizen Science Global Partnership (CSGP), a group of 63 citizen science practitioners from 24 countries contributed to the process of drafting the UNESCO Recommendation on Open Science. UNESCO has asked the CS&OS CoP and associates to provide guidance for country governments on how to embed the open engagement of societal actors in their (Open) Science policies to ensure that this pillar is suitably addressed and incorporated in the implementation of the Recommendation around the world. In response to this request, 37 people from 21 countries collaborated in a short and concentrated effort to gather and review relevant resources and case study examples, and present these along with the below guidance on successful approaches and mechanisms for embedding the open engagement of societal actors in (Open) Science policy.

This guide is structured as follows. Section 2 presents an overview of the range of approaches that the opening up of science to society comprises. Section 3 elaborates on concrete policy recommendations for embedding the opening of science to society in Open Science policy and proposes key aspects to consider when monitoring societal engagement as part of the larger UNESCO Open Science monitoring framework. Section 4 illustrates current efforts and advances of a number of countries and regions which include the opening up of science to society in their (Open) Science policies with case studies from the EU, Austria, The Netherlands, the US, South Africa, India, and New Zealand. Finally, section 5 includes useful links to resources such as inventories of (online) citizen science projects, tools and methodologies for setting up and implementing societal engagement initiatives, as well as a platform for measuring their impacts.

2 - **What do we mean by the open engagement of societal actors & dialogues with other knowledge systems?**

Opening science to society via the open engagement of societal actors and dialogues with other knowledge systems consists of a landscape of approaches and practices that involve, or are initiated by, stakeholders across society. One of the most prominent forms is citizen science. While this term is often understood to primarily involve the crowdsourcing of data collection or data processing by volunteers, in practice it entails many forms of collaborating with (other) members of the public in knowledge co-creation and application. A recent study capturing the views of 333 citizen science practitioners highlighted the pluralities of citizen science and that context-specific definitions are needed [1]. Common to the different interpretations is that citizen science:

- Involves participants in one or more steps of the scientific research process;
- Is practised across all areas of research and knowledge production, from environmental or health conditions monitoring, to social science topics;
- Is applicable across all scientific disciplines, alongside a variety of disciplinary traditions and research methods;
- Follows protocols and principles of the discipline within which the research is framed; and,
- Varies in terms of the roles, responsibilities, and leadership opportunities for scientists, their fellow citizens, and other stakeholders.

The diverse societal engagement practices display a range of initiators as well - from science-driven ones, to community-driven and those initiated by authorities and monitoring agencies - along with a range of purposes (such as scientific investigation, conservation, local action and education). Community science, community-based participatory research and citizen observatories are forms of societal engagement with a particularly prominent role for communities in defining scientific enquiries driven by societal challenges, relying on their knowledge and local experience and expertise. They differ in terms of the role of communities, with community science and community-based monitoring presenting the most explicitly 'bottom up' approaches. Societal engagement approaches present diverse opportunities for dialogues with other knowledge systems, e.g. by including and elevating local, traditional and Indigenous knowledge. The extent to which this is achieved, and in which ways, is subject to evolving best practices and requires careful and sustained attention.

Other forms of civic participation exist that may include practising science, but might not be labelled by their initiators or others to be citizen science or participatory science - these should also be considered when describing societal engagement with science. All societal engagement approaches embody different notions of expert knowledge and are affected by structures that influence science dynamics at work, including which questions are asked, which methods are used, how data is shared and who can access and analyse any data collected. The diversity of societal engagement approaches is indicative of the changing role of science in society and the shifting interactions between science, society and policy, illustrating that universities no longer have the monopoly over knowledge production.

Societal engagement initiatives are embedded in and responsive to a number of dynamics and aspects [2]:

- *Thematic, geographic & temporal dimension*: the characteristics and priorities of stakeholders in a specific geographic area, the thematic focus (e.g., water, biodiversity, etc.) and the timing of the resource/object/issue observed.
- *Socio-political dimension*: the social dimension of citizen science and other forms of societal engagement encompasses the involvement of diverse stakeholders in knowledge co-creation, with differing perceptions, motivations, expectations, capacity, priorities and local, traditional and/or Indigenous knowledge backgrounds; citizen science is also a political multi-stakeholder process in

terms of who decides what is measured by whom, how and when; what data (and how) are included with respect to reporting requirements, monitoring objectives and decision-making processes.

- *Scientific dimension*: in terms of scientific discipline, citizen science needs to be integrated with, and validated for, specific scientific/knowledge fields; in terms of scientific method, citizen science constitutes a change to the traditional scientific paradigm—from providing merely a new data source for scientific enquiry, to involving fellow members of the public and communities in the scientific method.
- *Technological dimension*: the technological dimension of citizen science entails the innovative application of information and communication technologies and new instruments such as sensors; the use of new or adaptation of existing interaction platforms; and citizen science data access, interoperability, compatibility, complementarity and integration with standard data sources, as well as technology and data sovereignty debates.
- *Financial dimension*: this dimension pertains to the influence of financial resources on the scope, success and sustainability of citizen science activities, as well as to the economic benefits derived from citizen-generated data, e.g., for the public good and/or for the benefit of private sector actors from value-added services.

Attention to the governance of societal engagement processes is important to ensure more egalitarian practice and knowledge co-production. Lack of awareness, acceptability and sustainability are well-known barriers for the broader uptake of societal engagement approaches such as citizen science and citizen observatories [3]. An enabling environment for the open engagement of societal actors and dialogues with other knowledge systems promotes awareness of their potential, validation of their contributions to science, acknowledgement of and willingness to address policy and societal challenges, and sustainability for their activities. Open Science policies are key for establishing this environment and for leveraging the potential of societal engagement in science to address key societal challenges, especially those encompassed in the Sustainable Development Goals.

Glossary of different forms of opening science to society via open engagement of societal actors and dialogues with other knowledge systems

Term	**Description**
Citizen science	Participation, in whole or part, in the scientific life cycle by those who do not hold credentials typically associated with that field of science [4].
Community-based participatory research	Collaboration with communities most affected by an issue, enlisting them to conduct research, and devising solutions together, often in a health, public health, or environmental context [5].
Community science	Science initiated by communities underserved by scientific institutions, and elevating local expertise and issues above academic interests [6].
Community-based monitoring	Routine observations of environmental or social phenomena, or both, that are led and undertaken by community members and civil society associations, and can involve external collaboration and support of visiting researchers and government agencies [7].
Citizen observatories	Community-based environmental monitoring and information systems, that invite individuals to share observations, typically via mobile phone or the web. Emphasises two-way flow of information

	and citizens conducting environmental monitoring [3]
Crowdsourcing	Distributing a discrete set of tasks - such as data collection or processing - among participants, often used to lower costs or increase the speed of research for those running a project [8].
Listening at scale/ implicit sensing/ social media listening	Employing data science methodology - including machine learning and natural language processing - to surface consensus from differing opinions among a large population [9].
Participatory action research	Involving an affected community throughout research with a specific problem to solve, often used in the social sciences and sometimes includes taking political action [10]
Science shops/Citizen science labs	Mechanism (typically of universities) for initiating challenge-driven research defined by citizens and communities and undertaken with and by scientists [11].
LivingLabs	Innovation experiments with stakeholders of the quadruple helix (academic, private sector, public sector, civil society) in their real-life setting [12]. The extent to which LivingLabs serve to open up the scientific process varies greatly, however.

3 - Recommendations for opening science to society via Open Science policy and for monitoring of policy implementation

This section elaborates on concrete policy recommendations for embedding the open engagement of societal actors in Open Science policy and proposes key aspects to consider when monitoring the societal engagement as part of the larger UNESCO Open Science monitoring framework. It is based on a review and thematic analysis of 33 documents with policy recommendations specifically related to the open engagement of societal actors [13-47][1]. The policy instruments relate to the creation of an open understanding of open engagement of societal actors, capacity building at different levels, infrastructure and services for open engagement of societal actors, and funding mechanisms.

Open understanding of opening science to society

Empowering and engaging societal actors through open engagement

Policies should empower and engage societal actors through open engagement, not only from the top down. Open engagement of societal actors and dialogues with other knowledge systems can strengthen civic engagement, trust in science, and support for evidence-based policymaking among the public. To achieve these aims, policies must go beyond facilitating public participation in scientific processes that are led from the top down. Instead, policies must embrace open engagement as a mechanism for more democratic knowledge generation approaches, including the co-design and co-formulation of scientific questions, priorities, and approaches, in addition to collecting, interpreting, and where relevant, acting on data. Open engagement can be used as a dialogue tool, allowing citizens to be heard in new ways and to be more than mere data contributors. This shift in mindset to view societal actors as essential partners in the scientific process requires policy support and funding (see section on Funding for open engagement of societal actors) at all levels of public infrastructure (see section on Capacity building for open engagement of societal actors).

Policies should foster transparent communication and long-term relationships with trusted community partners. To effectively partner with the public in scientific problem formulation, data collection, and knowledge creation, it is useful to draw links between national- and global-level targets and the local-level manifestations of global concepts. Policies seeking to connect with societal actors on a local level should implement engagement through trusted partners and organisations at a relevant scale, including local natural resource managers, libraries, museums, community centres, universities, colleges and schools. Communication should be transparent, rooted in a spirit of openness and listening, and should aim to foster a long-term relationship between societal actors and relevant scientific and government institutions. Policies need to take into account the values of people involved, conflicting or competing interests, policy objectives and outcomes, and policy evaluation (see section on Monitoring open engagement). Additionally, activities and resources created to train and empower participants to produce and make sense of their own collected data can improve practice and policy, and can lead to the emergence of bottom-up collegial citizen science and other participatory scientific activities.

Policies should ensure free and open access to educational content and enhance science and data literacy. Effective open engagement of societal actors will be strengthened by continuous investment in science education and data literacy. Open education is an essential component of open scientific knowledge, and policies should actively support free and open access to high quality educational content and opportunities. Policies that

[1] In the interest of formulating clear recommendations, the text in this section at times draws verbatim on selected aspects of the reviewed documents.

promote the engagement of societal actors in scientific activity, such as citizen science and crowdsourcing, can use these forms of engagement as a platform to increase public familiarity with open science and evidence-based policymaking more broadly. Other investments in public education, particularly in the field of data literacy, can be implemented through public institutions such as schools and libraries (see section on Capacity building on open engagement of societal actors). Innovative participatory approaches to open education include cross-disciplinary and multi-lingual wikis, communities of practice (such as the WeObserve CoPs), and MOOCs.

Diversity, equity, inclusion, and justice in opening science to society

Policies should ensure engagement of and partnerships with marginalised communities. To date, Black and Indigenous communities and other communities of colour have been largely marginalised, and are under-represented in large-scale science engagement and citizen science efforts. True collaboration requires consultation with the impacted communities, especially those that are typically under-reached, before the project work is defined and launched, and may mean reframing the goals or focus of the initiative to address community priorities. Additionally, countries with Indigenous populations should actively consider partnerships with tribal education programs, and tribal colleges and universities. Engagement of societal actors should be culturally consistent with Indigenous worldviews in science, and Indigenous Knowledge (IK) and Tribal Ecological Knowledge (TEK) systems should be valued in their own right. There are ways to mutually share knowledge without appropriation, and any open engagement policies should always come from a perspective of respect. Indigenous guidance (for example, that of the Global Indigenous Data Alliance) should be consulted and Indigenous scientists and societal actors should be involved in scientific engagement that relates to IK and TEK.

Policies should support non-traditional venues for scientific activities and accessible communication. Open Science policies must be intentionally designed to seek to understand the needs, motivations, and effective means of engagement with communities that have been disenfranchised in the past. This will frequently require building long-term relationships with these communities and empowering individuals from within these communities with leadership roles in open engagement. Policies should be prepared to fund facilitating organisations and communication channels that may not have traditionally been seen as venues for scientific activity, including libraries, community centres, and schools (see section on Funding for whom). To reach broad audiences, policies must be mindful of communication approaches; communication materials should be translated into all relevant languages, principles of universal design should be followed to maximise accessibility of communication materials, and multiple modes of communication should be used when possible.

Policies should ensure benefits of societal engagement reach all involved stakeholders. Globally, open science can break down barriers that separate scientists from rich countries from those from poor countries, and this outcome must be actively fostered in open science policies. Access barriers that may limit scientists from economically disadvantaged countries from fully participating in open science, including limited technological and computational resources, disproportionate opportunity costs and lack of career benefit, must be addressed. The same holds true for open engagement of societal actors: policies must grapple with the question of who will benefit from open engagement, and should ensure that the communities being invited to participate will have their own priorities taken into account and will receive reciprocal benefit from participation.

Capacity building on opening science to society

A culture of societal engagement should be fostered by embedding the concept within internal and external training, outreach, and support at all policy levels. Awareness raising, education, training, knowledge exchange,

and availability of resources are the foundations to build mutual trust between policymaking institutions and the public, which is an enabling condition for societal engagement. Support for capacity building should be long-term to sustain ongoing leadership, coordination, and legitimation for the ever-widening range of societal engagement methods available. Key stakeholders should be encouraged to support and implement capacity building activities. Training should be encouraged and supported in both formal and informal contexts and needs to be adapted to a diverse range of stakeholders, including at the national and policy levels, as well as institutional and individual levels.

Capacity building at the national and policy-maker levels

An enabling policy environment cuts across governance levels. Open engagement of societal actors and dialogues with other knowledge systems will look different across various government institutions; therefore, high-level policy should be accompanied by explicit integration of open engagement into institution-level policies, strategies, and values. These policies should include measures to equip all relevant staff (such as local, regional, and national government officials and scientist-regulators) with sufficient capabilities to carry out effective open engagement and to encourage them to become proponents of societal engagement approaches, become familiar with citizen potential in science, and share success stories. Local government officials in particular, are the closest and generally the first contact that citizens have with the government, so should be well trained in this area, including in communication, training and support, and interacting with local organisations and citizens. All relevant staff and institutions can be integrated into a cross-cutting community of practice, which can be supported by one or more dedicated positions that serve as a primary point of contact for open engagement. Where relevant, the development of a common framework for incorporating knowledge generated through open engagement into policy- and decision-making can both provide top-down support for institution-level open engagement and promote synthesis among institutions' engagement strategies.

Leverage existing resources. Successful open societal engagement is best supported by an approach to policy development that can adapt and iterate in response to emerging best practices. This environment can be created by establishing a centralised portal to track progress in open engagement across government institutions, including reports, assessments, and examples of current approaches (see section on Infrastructure and services for open engagement of societal actors). Translating and disseminating the existing knowledge on societal engagement will clarify the kinds of societal engagement that are relevant at different policy levels and contexts. Use of a common vocabulary to refer to open engagement practices will further facilitate identification of cross-cutting opportunities. Current contributions of open engagement to policies must be clearly and explicitly identified in all relevant reports and publications.

Foster multi-level and multi-stakeholder policy connections, finding pathways for societal engagement across environmental, agricultural and climate policies, e.g., through the creation of citizen observatories. Establish collaboration between societal engagement initiatives and public institutions with a scientific link, such as museums, libraries, and education institutions. Ministries of Science and other government institutions could issue clear guidelines and policies for how non-governmental organisations and other societal actors can approach the institutions with proposals for collaborative efforts. A citizen science contact point could be created in public research bodies and relevant ministries. National governments should bring together and provide support for organisations that have begun to implement open science reforms to recruitment and career progression processes and learn from those that have taken the initiative to embed open science and societal engagement in their processes.

Capacity building at the institutional and individual level

Foster capacity building and academic recognition within Higher Education Institutions (HEI). The institutionalisation of open science and specifically the engagement of societal actors and dialogues with other knowledge systems should be supported strategically and financially [see section on Funding for open engagement of societal actors] in higher education institutions and other research performing organisations. Within HEI teaching, Open Science topics such as community-based participatory research, citizen science, and open access should be embedded in general research education and training, especially in post-graduate courses. For HEI staff, education and training on public engagement, including customised training for specific staff groups, is needed to overcome scepticism and opposition. A culture of recognition should be established to encourage open societal engagement. Within research performing organisations and academia, performance metrics and criteria should be revised to support and reward open engagement. University ranking should also reward societal engagement. At institutional levels, structures and strategies should give services and guidance regarding societal engagement, further developing a culture of engagement. A range of other recognition instruments can also be developed in collaborations between ministries, authorities, citizens, and research institutions (e.g., citizen science awards). Agreements with existing associations, groups, civil society organisations, or schools can be established to inspire greater interaction with societal actors and the general public (e.g., through Science Shops or collaboration with teachers and schools). Community Engaged Learning (CEL) at tertiary level in HEI benefits both the students and community participants.

Foster societal engagement through schools, high schools, and life-long learning programmes. Ministries of Science and Education should strategically and financially support and initiate the integration of societal engagement, for example through use of citizen science activities, into curricula and teacher training for schools and lifelong learning programmes. Citizen science should be embedded in educational programmes at early stages with children to increase scientific literacy and incentivise future citizen scientists. Recognition should be available for the citizen scientists, either economic or curricular.

Support informal training initiatives: National associations, Citizen Observatories, and individual citizen science projects engaging with societal actors, especially trusted actors in local communities, often run important and successful capacity building initiatives. Opening data is not a sufficient step for Open Engagement. Capacity building amongst citizens and interested communities is essential so that they can enjoy the benefits of the available data, e.g. learning to interpret water quality data of their local river, or air pollution data. Otherwise, only groups and companies with the right mix of skills can benefit from and capitalise on open data. Open engagement initiatives should be supported strategically and financially to facilitate training of diverse stakeholders, including local organisations, marginalised groups, and local community members. Encourage official recognition of national associations of citizen science and Citizen Observatories.

Knowledge exchange opportunities

Prioritise impact at scales from local to global: Whenever possible, policies supporting open societal engagement should align with international standards for open science to allow for leveraging of resources, sharing of best practice, and synthesis of policy outcomes across national boundaries. However, to ensure that international alignment does not inadvertently introduce barriers to local implementation, local societal stakeholders must be consulted early and often in policy development. This engagement should be accessible to all relevant stakeholders, including accessibility in non-technical language and the offer of technical assistance or specific training where relevant.

Support the development of dedicated platforms, infrastructures, and fora for practitioners of open societal engagement to support the sharing of experiences between stakeholders and give the opportunity for

synergies and collaborations (see section on Infrastructure and services for open engagement of societal actors). Synergies with existing networks (e.g. C40 cities) could be built on. Furthermore, inclusivity and diversity of actors should be specifically encouraged within collaborative approaches. Enabling exchange and dissemination of knowledge among projects and stakeholders can help identify and propagate the benefits and impact of engaging societal actors. Strategic partnerships across all sectors of society are important for knowledge exchange.. Material support is required for the creation of networks and relationships with and between excluded CSOs. In general, partnerships for open societal engagement should be strengthened and established, also between the Global North and the Global South, focusing on concrete actions (e.g., to facilitate the implementation and advancement towards the SDGs).

Ensure accessible resources: Resources, such as guidance, outreach materials, technology and data handling and processing recommendations, as well as the state of the art in collaborative approaches (such as participatory design methods), should be readily available in specific repositories targeted at specific stakeholders. Open access (OA) and open data are mechanisms that facilitate access to scientific materials and methodologies to a wide range of societal actors, hence support for OA publications and open data sharing are needed.

Infrastructure & services for opening science to society

Develop centralised infrastructure for societal engagement in order to enable exchange between and across initiatives, host interactive and step-by-step toolkits (such as the WeObserve Cookbook), and operate as a screening system for purpose-specific search for projects in line with quality standards. This online infrastructure can be developed at national or regional level, which could be provided by government and/or scientific institutes or in a more bottom-up manner. Platforms such as EU-Citizen.Science offer a template for how this can be done.

Open data sharing (incl. FAIR principles - findable, accessible, interoperable & reusable; along with the option of open data licensing) should also be incorporated into centralised infrastructures. In order to allow for citizens' involvement in data analysis and visualisation, policymakers should provide accessible infrastructure to process data generated by societal engagement initiatives (especially environmental, land use, urban structure, socio-economic and other geodata) and transfer them to a common spatial data infrastructure or data catalogue (as an example, the Global Biodiversity Information Facility demonstrates a current approach to international open data infrastructure in the context of biodiversity data). To achieve this at a global level, the Global South should be supported with better internet access and shared, community-governed and not-for-profit digital infrastructure for their citizens, as well as researchers and universities.

Encourage reusability and interoperability by developing standards that require input from societal actors on the re-use, repair and further development of existing technologies. Promoting open source software and hardware, shared code bases, and sustainable hardware is central to including societal actors in science and supports initiatives through the availability of a richer set of features and functionalities that can be applied and adapted to other contexts. At the university level, administrative infrastructure and resources, such as the support of Data Stewards and Data Competence Centres, should be available to support community-university research partnerships that empower people of all abilities to make and use accessible, open source technologies.

Support bottom-up development of infrastructure to allow citizens and societal actors to shape the tools that they will use when engaging with science. This can be done with the use of (digital) "living labs", Digital Innovation Hub Networks and sandboxes to allow for collaboration and experimentation. Additionally, the

available infrastructures can then also be used to give access to small research groups, technology centres, and companies.

Funding for Opening science to society

Funding for what

Foster open societal engagement and dialogues with other knowledge systems in science. Offering mechanisms for funding that address the differing characteristics of projects that embrace the open societal engagement and dialogues with other knowledge systems in science is essential. Such projects often require relatively high start-up costs to identify and engage different stakeholders to be involved and to keep them motivated, and for their needs to be identified via co-design processes. As such, there must be funding instruments that allow for "yet to be defined" outcomes of proposals based on societal engagement in order not to bias funding towards the 'safe bets'. These should step outside conventional, pre-defined deliverable-based funding models and provide flexibility for scoping phases for the co-design of research agendas and for accepting changes to project execution. Appropriate financial support is also necessary for community management (e.g. fund positions and horizontal measures for community management), for the iterative development of sustainable infrastructures and facilitating technologies such as mobile applications and data platforms (see section on Infrastructure and services for open engagement of societal actors) and for other non-research functions characteristic of citizen science and other forms of open engagement of societal actors. Set clear legal and ethical criteria for data privacy of engaged stakeholders according to existing laws, such as personal data control.

Support should be provided for series of often small-scale experimentations, as well as for exploring different routes for the upscaling and long-term sustainability of initiatives aiming to generate science for social change. Scale proven approaches in order to move beyond (often still dispersed) piloting. Make follow-on or alternative sources of funding available to projects that hit key performance indicators, in order to fully maximise the potential for societal and environmental impacts. Increase and diversify the opportunities for small seed funding for project prototyping and experimentation with the open engagement of societal actors.

Mainstreaming societal engagement in all funding: To mainstream societal engagement in all research, the full range of research grant programs available should be adapted to reward participatory methods. Various forms of societal engagement in science should be called for in grant requests or precursors to actual grants, such as "Dear Colleague Letters". Funding schemes in general should stimulate and reward research that uses citizen and participatory science. Also, strategic and financial support should be provided for research collaborations between communities and universities (as exemplified by Canada's many programmes on partnership research), to citizen science networks, capacity-building activities and initiatives, dedicated coordination and support actions across projects implementing open engagement of societal actors to foster peer-learning, as well as to changes in research organisations, whilst also supporting the active engagement of citizens in implementing the SDGs (see section on Capacity building for open engagement of societal actors). Actively connect governmental and scientific research funding with societal challenges and promote citizen and participatory science as a method to do so. For example, this can be done by opening portions of large government contracts for utilities and services to participatory science-based activities and products and through annual funding programmes for societal engagement at the local level. Existing funding processes can be redesigned to be more inclusive of citizen science efforts, such as by embracing a more cooperative model or a pooled approach. Structural funding to municipalities and regions (such as Provinces of states) can embed citizen observatories for community-based environmental monitoring within the local city-planning, policy-development, and management cycles.

Funding for whom - recipients & purposes: Financial support should be available for a wide range of actors, including small, local initiatives that can help engage local communities, grassroots and community-based organisations in science. Funders should request appropriate governance structures for creating multi-actor coalitions and engaging civil society actors throughout the research and innovation process. For regional funding schemes, funding could be particularly aimed at countries in which citizen science and other forms of societal engagement are not yet mainstream. Also, funding should be made available directly to community-based organisations as well as universities and indeed not only allow for but also require, as appropriate, that community-based partners (CSOs as well as citizens) be the direct recipient of grant awards, and consider the compensation of non-university actors to allow for equal participation in open science. Care should be taken not to assume that civil society organisations lack the capacity to be the recipients, and there should be no different measures of proof and oversight mechanisms for them (compared to universities) to account for their capabilities, to avoid reinforcing community partners' concerns about lack of trust and equity. Similarly, allow small businesses and other non-academic research organisations to serve as principal investigators for citizen and participatory science projects, as well as streamlining the procurement process to make it easier for small businesses and non-academic research organisations to submit proposals. To this end, funders should develop guidelines, templates, and tutorials for procurement of necessary services, tools, and resources to support citizen science and crowdsourcing projects (see section on Capacity building for open engagement of societal actors). Intermediary bodies can be set up to process the flow of funding to societal actors without a formal legal entity to aid transparency, accountability and compliance. Scientific institutions, organisations, administrations, educational institutions, associations and professional societies should support citizen science coordinators and communicators through third-party funding or permanent positions.

Funding for how long: The longer term nature, ambitions and ethical responsibilities of many forms of open engagement of societal actors mean that operational and maintenance costs can extend beyond the end of defined project funding, especially when an engaged community of participants wishes to continue to monitor a local issue of importance to them. Therefore, funding models need to be provided which recognise the focus on creating relationships with diverse stakeholders and on community building, the longer time periods over which these forms of societal engagement are typically create and operate, allocating appropriate long-term funding to support sustainability. Initial planning grants (e.g. 1 year), as part of a longer-term funding initiative (e.g. 5 years) can help develop and then maintain the long-term partnerships and infrastructure needed for societal engagement in science. Funding agencies can guarantee subsequent funds for all partnerships that successfully fulfil the requirements of the planning grant. Second, technical assistance might be offered to partnerships not able to meet all of the requirements during the planning period to become more effective in competing for subsequent funds. Long term funding horizons, in turn, rely on multi-annual budgets and political commitment.

Funding by whom: There is a need for public and private funding agencies to collaborate to develop and implement co-sponsored grant initiatives that foster societal engagement in science. This relies on the co-ordination of alternative sources of funding with more traditional ones, enabling public-private co-financing and philanthropy. To this end, a regulatory environment must be developed (laws of patronage, crowdfunding, venture capital with attractive taxation) that facilitates and stimulates private investment in research and innovation that embraces the open engagement of societal actors. Provide innovative funding schemes and funding support functions (e.g. guidance on how to obtain direct funding as well as other funding).

Fit-for-purpose funding instruments & evaluation: The funding criteria for societal engagement should specifically address quality criteria of good societal engagement, the integration of citizen science data in existing data schemes and the connection with societal challenges like linking to the Sustainable Development Goals. Fit-for-purpose funding instruments can best be accomplished by co-creating them together with the stakeholder groups that they aim to serve, who have experience with the unique needs and considerations of

societal engagement initiatives in those contexts. CSO participation in the creation of calls allows them to better align them to their needs and capabilities. Greater clarity on how funders expect CSOs to be able to participate in calls as well as intentional efforts from funders to reach out to small and medium sized CSOs. Similarly, the review criteria for judging applications and final evaluations of projects practising the open engagement of societal actors need to recognise a wide range of success criteria, including but not limited to traditional measures of scientific quality. The persons involved in the review process need to be consistent with societal engagement principles themselves: the input of community participants in the review process must be heard and incorporated into the final decision. Community members' perspectives and expertise might best be applied to assess specific partnership-related criteria across *all* applications, rather than taking a lead review role on the entirety of a few applications.

Monitoring Open societal engagement in science

Existing systems (funding, rewards, impact assessment and evaluation) need to be assessed against and adapted to open societal engagement practices and policies. Regional and national policy makers, research funders, universities and other research performing organisations should reform existing indicators, measures and processes to ensure these include evaluation of societal engagement practices. Open societal engagement impact must be documented and disseminated to evidence its value and support the case for its adoption. Relevant scientific data and actionable insights will reach their highest impact when they are open, accessible, and easy to understand for all actors. Best practice and key case studies should be highlighted within and across relevant agencies. For example, consolidation projects such as WeObserve enabled the analysis, documentation and dissemination of best practice of four European Commission-funded Citizen Observatories, encapsulated in the WeObserve Roadmap and Cookbook, which now serve to further the state of the art

To measure the impact of societal engagement, appropriate methods are needed. H2020 projects in Europe such as Making Sense, GROW Observatory and MICS, have started to develop metrics and instruments to capture and evaluate citizen science impact. These metrics can be adapted to other open engagement policies and projects. Citizen science can facilitate new narratives on how open and participatory science as a policy tool can empower policymakers to generate more societal impact by engaging with citizens and science in a systematic way. This would expand the narrative of 'open science' to 'open policy'. Citizen science can also contribute to monitoring progress towards the SDGs and to translate the SDG global framework and message to local realities.

A recent systematic review of impact assessment methods for citizen science identified the following six guiding principles for a consolidated citizen science impact assessment framework [38]: (1) acknowledging that there are a variety of purposes for citizen science impact assessment; (2) conceptualising non-linear impact journeys to overcome impact silos; (3) adopting comprehensive impact assessment data collection methods and information sources (qualitative as well as quantitative); (4) moving beyond absolute impact to include relative impact; (5) fostering comparison of impact assessment results across citizen science projects; and (6) cumulative enhancing the framework over time. Governments are recommended to adopt a consolidated framework such as this one to overcome the dispersal of approaches and gaps in assessing the diversity of impacts that societal engagement in science can generate. Integration with the design and assessment of budget packages and funding calls is essential.

4 - Case studies of current efforts with opening science to society via national/regional (Open) Science policies

This section offers case studies from the EU, Austria, The Netherlands, the US, South Africa, India, and New Zealand as practical examples of policies designed to progress the societal engagement pillars of the UNESCO Open Science Recommendation. They have been gathered with the explicit criterion of identifying either regional or national science policy efforts with the purpose of "opening science to society" in national and or regional contexts. Together, they demonstrate the diverse processes involved in designing policies to progress the open engagement of societal actors and facilitate open dialogue with other knowledge systems in scientific research and policy outcomes. In a number of cases, the policies are too recent to be able to offer information about monitoring, evaluation and lessons learned.

It is indicative that many countries are only just beginning the journey of instituting policies that support the opening up of science to society, so we hope that this small collection of policy documents and case studies will be added to and built into a significant and valuable resource through the national reporting on progress towards the Open Science Recommendation.

European Union

Elaborated by Muki Haklay

The European Union Research and Innovation programmes are amongst the largest in the world. Known as "Framework Programmes" (FP), these 5 to 7 years programmes are key instruments for implementing EU Research & innovation policy and they shape the landscape of European research in the EU member states as well as other countries in the region. The EU pioneered the recognition of the importance of elements of Open Science early on. Already in FP6 (2002-2006), cross-European open data infrastructure projects started, and during FP7 (2007-2013) strong support for Open Access was part of the policy agenda. By 2012, the EU recommended these two elements to all the member states (Commission Recommendation 2012/417/EU). In his time as the commissioner responsible for research and innovation (2014-2021), Carlos Moedas made Open Science a top priority. By 2015, the opening of science to societal actors was integral to this concept and had been integrated into the goals of the Open Science Policy Platform - a body set up to help in shaping the EU Open Science policies. The results of this transition is strong policy and funding support for citizen science and societal engagement across the latest programmes - FP8 (Horizon 2020) and FP9 (Horizon Europe). In the latter, societal engagement is written into the legislation and is part of the evaluation criteria of all proposals. Throughout its development, the process of shaping the open science policy was led by science policy experts in the European Commission, but with an ongoing effort to engage with a wide range of stakeholders (including, for example, publishers in the area of open access).

The current support for societal engagement is robust. For example, during the Horizon 2020 Framework Programme, "Science with and for Society" was a core programme that funded 22 projects directly linked to citizen science and societal engagement, with a total value of €58.3 million. Beyond this dedicated funding, analysis by the EC identified 338 projects across all research areas covered in Horizon 2020 that engaged societal actors, approaching 1% of the total number of projects funded. The recorded impacts of these projects are recognised by the EC and member states, and have led to instruments such as a Mutual Learning Exercise on Citizen Science between 11 member states in 2022, to promote citizen science within the EC Member States and regions, scale up citizen science campaigns, and form a greater cooperation and shared approaches across the European Research Area.

The example of the European Union is demonstrating how a policy initiative and catalysis through a range of instruments can successfully increase awareness, capacity, and engagement. The combination of direct funding

of projects, especially those that are aimed at coordination and support, combined with an integration of societal engagement as a cross-cutting evaluation theme helped in mainstreaming societal engagement.

Austria

Elaborated by Barbara Heinisch

In Austria, several policies address the open engagement of societal actors. The Open Innovation Strategy for Austria was commissioned by the Federal Ministry of Science, Research and Economy and the Federal Ministry for Transport, Innovation and Technology and compiled with the technical support of winnovation consulting gmbh and Community-based Innovation Systems GmbH. In a one-year, open-ended process involving 500 persons from the public and stakeholders (science, business and policy), a strategy was developed presenting a vision for 2025. The online portal openinnovation.gv.at allowed stakeholders, interested members of the public and experts to discuss their ideas for the Strategy following an open workshop resulting in a first draft. The general public was invited to an online consultation. In July 2016, the Austrian Government adopted the Strategy.

To increase Austria's innovative strength and competitiveness by means of open innovation, three key areas are addressed:

- Development of a culture of open innovation and teaching open innovation skills among all age groups
- Formation of heterogeneous open innovation networks and partnerships across disciplines, branches of industry and organisations
- Mobilisation of resources and the creation of framework conditions for open innovation

The Open Science Policy was developed based on the Directive (EU) 2019/1024 on open data and the re-use of public sector information. In 2020, OANA (Open Science Network Austria established under the umbrella of the Austrian Science Fund (FWF) and the Austrian University Conference) published its recommendations for an open science strategy in Austria. It should implement the Vienna Principles (a vision for scholarly communication). The recommendation for an Open Science Strategy was subject to public consultation. The Recommendation for an Open Science Strategy forms the basis for Austria's contribution to Open Science and the European Open Science Cloud.

The eight core tasks of Open Science are: 1) Rewards and incentives; 2) Research indicators and next-generation metrics (research evaluation, evaluation metrics); 3) Future of scholarly communication; 4) European Open Science Cloud; 5) FAIR data; 6) Research integrity; 7) Skills and education (skills creation and open teaching); and 8) Citizen science.

Several research funding schemes are dedicated to citizen science, including the Austrian Science Funds' (FWF) Top Citizen Science scheme as a citizen science add-on for projects in the field of basic research or its Connecting Minds programme for transdisciplinary research or the Federal Ministry of Science, Research and Economy's Sparkling Science scheme involving school children in research as well as the innovation laboratories for early-stage involvement of users in innovation processes by the Austrian Research Promotion Agency (FFG) or the Public and Patient Involvement and Engagement programme for citizen and patient participation activities by the Ludwig Boltzmann Society.

Especially funding of dedicated research projects that engage members of the public as well as funding of specific involvement activities increased the open engagement of societal actors in research in addition to a dense network of formal and informal institutions related to open science and citizen science (e.g. Österreich forscht!, Zentrum für Citizen Science, Open Science Austria).

The Netherlands

Elaborated by Margaret Gold

Open science was a top priority during the Netherlands EU presidency, during which the Amsterdam Call for Action [48] made the recommendation that each Member State should draw up a National Plan for Open Science. The first National Plan Open Science [49] was developed by a broad coalition of key actors in the Dutch research landscape (such as the Association of Universities, the Research Council, and the Research Supporting Organisations) in response to a request from the State Secretary for Education, Culture and Science, and signed in 2017 [50].

As collaborations between the parties to that agreement developed and strengthened regarding the shared ambitions for Open Science, the group established a programme structure and became the National Programme Open Science (NPOS) in 2019. The aim of the programme is to achieve a coordinated effort towards the transition to Open Science, and to disseminate its importance. To coordinate these endeavours, NPOS has received annual funding from both the Ministry for Education, Culture and Science, and from the Association of Research Universities. The NPOS Steering Committee has the task of managing the transition to Open Science on a national level, with advice (both solicited and unsolicited) from an Advisory Board. These two groups consist of the directors of the largest research performing and funding organisations in the Netherlands, the National Library and Royal Academy of Sciences, and research supporting organisations such as the eScience Center. Implementation rests with the various parties involved.

A group of active citizen science practitioners formed a Working Group in 2020 in a bottom-up initiative to embed citizen science within the NPOS Programme - resulting in a report recommending citizen science become a third Programme Line within NPOS, alongside FAIR Data and Open Access (actualised in 2021), and that a national network for citizen science be established (launched in 2022).

A much more ambitious perspective towards Open Science took shape over the course of 2021 in response to the UNESCO Recommendation on Open Science, and the NPOS strategic goals and ambitions towards 2030 (to which 78 institutions, networks, communities and individuals have given their constructive feedback via an open consultation process) have been aligned with the UNESCO Recommendations, the first goal being: *"Close collaboration between knowledge institutions, government, industry, and citizens to strengthen the international position of Dutch science and optimise the processes of creating, sharing, and communicating knowledge for the benefit of society"*. [49]

On 17 June 2022, the Minister of Education, Culture and Science announced in a Policy Letter on Open Science [42] that 20 million euros will be allocated for Open Science each year from 2023 to 2031, with explicit support for multi-stakeholder participation in the knowledge chain, bottom-up research practices that tackle societal issues, and participatory collaborations between scientific and societal actors. He asked the Dutch Research Council (NWO) to take responsibility for the spending of these funds and to set up a temporary 'Regieorgaan Open Science'. NPOS has responded to this development by developing a Rolling Agenda to achieve the NPOS Ambition 2030, the first of which is ***'Towards Societal Engagement and Citizen Science'***. Together, these NPOS outputs will inform the investment in Open Science in the Netherlands.

New Zealand

Elaborated by Libby Hepburn

Vision Matauranga [52] is a policy framework created in 2005 as a guiding structure for research funding in New Zealand. This is indeed a visionary Open Science policy created to provide strategic direction for funding for Research, Science and Technology of relevance to Maori to unlock their innovation potential to assist New Zealanders to create a better future. It recognises Maori as important partners in science and innovation.

This framework was the outcome of a second "Hui Taumata" extensive consultation round. The first was in 1984 and the second involved 450 people who reflected on the first 20 years and forged the vision for the next. The fact that this instrument is still being used today is testament to its effectiveness in delivering its objectives. This is not a policy for citizen science as such, but is an overarching strategy for the inclusion of first nations people in all aspects of the development and implementation of Research Science and Technology. Open science in which they are partners and which impacts their lives for the better.

There are four research themes in the policy: Indigenous Innovation, Maori contributing to Economic growth through distinctive R&D, Achieving Environmental Sustainability through Iwi and Hapü Relationships with Land and Sea, Exploring Indigenous knowledge and RS&T Innovation potential, Improving health and social wellbeing.

Capacity building for these was built via a number of initiatives including Maori-relevant Research Centres, Programmes and Organisations and encouraging new and emerging capacities and capabilities: research conducted by Maori organisations.

The policy is referred to in the request for proposals for science investment and National Science Challenges. Since its inception 86 projects have been funded from a current annual budget of $2 million.

The United States

Elaborated by Lea A. Shanley

Previously, U.S. federal agencies were often reluctant to use "non-traditional" citizen science data given the perceived risks [53], with some exceptions, such as the U.S. National Science Foundation [54,55]. To build trust and broaden adoption of citizen science within the U.S. federal government, the Commons Lab at The Wilson Center, a Washington-based think tank, launched a series of online roundtables and workshops starting in 2011 that connected federal employees with academic researchers, nonprofits, industry, and volunteer groups. With sponsorship from the Alfred P. Sloan Foundation, the Commons Lab also initiated nineteen studies prioritising the research challenges, bureaucratic barriers [53], risk reduction strategies, and data quality assurance methods for using citizen science in government.

In 2013, participants of a Commons Lab workshop [56] coalesced around the idea for a Federal Citizen Science Toolkit, which would provide federal employees with a step- by-step "how to" for designing, launching, and managing citizen science projects. This workshop also galvanised the establishment of the grassroots Federal Community of Practice for Crowdsourcing and Citizen Science (FedCCS), which was motivated by federal employees' desire to share lessons learned for advancing open science within their agencies. That year, the Commons Lab also initiated the development of a Federal Citizen Science Catalog, in collaboration with federal agencies, SciStarter.org, Citsci.org, and the Citizen Science Association, to increase the discoverability of federal citizen science projects, and to assess the scope and scale of federal investments in citizen science.

In parallel, the Commons Lab and FedCCS conducted numerous briefings with federal agency executives and White House staff to build high level support. As a result, the White House incorporated goals for the Citizen Science Catalog and Toolkit into the U.S. Open Government National Action Plans [57-59]. Briefings organised by the Commons Lab with the Office of Senator Coons in mid-2014, and by SciStarter.org with Congressional staff in 2015, catalysed and helped to propel Congressional passage of the Crowdsourcing and Citizen Science Act [51] as part of the COMPETES Act reauthorization in 2016.

The Commons Lab studies articulated the need for and the FedCCS provided significant input on the White House Memorandum on Crowdsourcing and Citizen Science [61]. The Toolkit, Memorandum, and legislation were announced at the first White House Citizen Science Summit in September of 2015, co-organized by FedCCS leadership. The event, titled Open Science and Innovation: Of the People, By the People, For the

People, sought to align with and expand the White House's Open Science priorities, which theretofore had focused primarily on open access to scientific publications. The FedCCS, SciStarter, and the CSA also joined forces to announce the first Citizen Science Day, which has grown into an annual global Citizen Science Month. As a planned culmination of the FedCCS community's efforts, the FedCCS, Toolkit, and Catalog were bundled as three core components of Citizenscience.gov in early 2016 [62].

Over time, the FedCCS blossomed to more than 350 federal staff representing 60 federal departments and agencies. Concurrently, agencies, such as the U.S. Environmental Protection Agency, the U.S. Geological Survey, the National Oceanic and Atmospheric Administration, NASA, U.S. Forest Service, NSF, and NIH, among others, grew thriving internal agency citizen science communities of practice.

The U.S. Government Accountability Office provided an assessment of federal open innovation and citizen science efforts [63]. The 2018 National Academies of Science, Engineering and Math consensus study titled, Learning Through Citizen Science: Enhancing Opportunities by Design, offered federal agencies a research agenda to advance our understanding of how citizen science can support science learning and enhance science education [62]. It also underscored the growing credibility of this emergent field.

Federal support for citizen science and crowdsourcing has continued through the Trump and Biden Administrations, resulting in the adoption of agency-specific citizen science strategies and policies (e.g., [55]), as well as reporting to Congress to comply with the requirements of the Crowdsourcing and Citizen Science Act (e.g., [65-66]). Agencies now see citizen science and open science as an opportunity to help solve scientific and engineering challenges, to monitor environmental conditions, to advance agency missions and improve service delivery, and to promote a spirit of curiosity and volunteerism.

* U.S. Case study adapted from:
Shanley, Michelucci, Tsosie, Wyeth, Drapkin, Azelton, Cavalier & Holmberg. 2021. Public Comment on Draft NOAA Citizen Science Strategy. Human Computation, 8:1:25-42 ISSN: 2330-8001, DOI: 10.15346/hc.v8i1.130
https://www.researchgate.net/publication/350554399_Public_Comment_on_Draft_NOAA_Citizen_Science_Strategy

India

Elaborated by Moumita Koley

In India, as in many countries, until now,the Science, Technology, and Innovation (ST) ecosystem has been the domain of the science establishment and the government with societal actors having minimal and insignificant roles. However, now it is being recognised that building an equitable, flourishing, and sustainable country needs better integration of society with the STI ecosystem. To make science and scientists more responsive towards societal exigencies, in the 104th session of the Indian Science Congress held in 2017 in Tirupati, the proposal to introduce the Scientific Social Responsibility (SSR) guidelines was discussed [69]. In 2019, The Scientific and Engineering Board (SERB), a statutory body of the Department of Science and Technology (DST), Govt. of India (GOI), first introduced an SSR policy [70]. DST released a more exhaustive guideline in May 2022 [71], detailing the aims and responsibilities of scientists toward society.

DST's SSR guidelines are based on the agreed understanding of the moral obligations of the scientific community to work for overall societal benefit. It aims to encourage the latent potentials of scientists in educating society using four broad strategies- a) Science-society linkages; b) Science-science Network; c) Society-science collaborations, and d) Cultural transformations to imbibe scientific temperament; this particular requirement is streaming from the Indian constitution, which states that every citizen should develop scientific temper as a fundamental duty.

Stakeholders range from knowledge workers and knowledge institutions as performers of SSR activities. Fund providers are government bodies and corporate entities. Schools, college students and teachers, women, social workers, farmers, and NGOs are the beneficiaries who benefit from the SSR activities. Institutions and agencies would carry out the SSR assessments part.

The guidelines suggested 17 different activities that the scientists could take up. Some of the prescribed activities include seminars by scientists to mobilise the youth to take up science as a career choice, nurturing talent through mentoring in school/ college projects, arranging science-based activities for hands-on training, popularising science through interactive talks in easy language, and promoting the activities of local/ grassroots innovators. Scientists working in the country's public and private knowledge institutions should contribute at least ten working days towards SSR-related activities. Due weightage would be given to their contribution to SSR activities in performance appraisal. However, it must be noted that the suggested activities are unidirectional—the guidelines lack in prescribing the ways for society to help in scientific knowledge creation. Citizen science is one such option that does not feature there.

The government would provide financial assistance to individuals and institutions toward SSR activities. Moreover, such activities cannot be outsourced or subcontracted by the knowledge institutions. Central Government Ministries and State Governments should strategize their SSR activities per their mandates.

SSR guidelines aim to assert the role of science for well-being through constructive and ethical communication of science to society. It is also expected that implementation of SSR at institutional levels will accelerate key GOI initiatives like, Make in India, Swachh Bharat, Digital India, and Transformation of Aspirational Districts.

South Africa

Elaborated by Jacqui Goldin

The South African National Research Strategy of 2012 has been developed with the intention of transforming the water sector so that the state becomes the custodian of water resources and that consultation and engagement happens at the lowest level involving all stakeholders. As such, it presents an example of national policy progressing towards Open Science and enacted to support SDG responses and reporting.

The National Water Act is the constitutional framework that states that every person has the right to an environment that is not harmful to their health or well-being, the right to have an environment that is protected, for the benefit of present and future generations. The NWA is exemplary - translated into over 100 languages and used as a baseline for participatory governance across the globe. It describes the transformation of irrigation boards into water user associations that are representative and inclusive of all users, not just commercial farmers as was the case with irrigation boards. The following are examples of national policy implemented through the National Water Resource Strategy that has been revised in a consultative way over the past 10 years.

Legal, regulatory and policy framework and purposes of national departments :

- The National Water Act (NWA): Protection and management of water resources to meet basic human needs (Chapter 1, 2 and 14)
- Water Services Act (WSA): Rights to access to basic water supply and basic sanitation
- National Environmental Management Act (NEMA): Management, sustainable use, regulation and protection of ecosystems, biodiversity, etc., including provision relating to cooperative governance and public participation
- Conservation of Agricultural Act (CARA): Management, sustainable use, regulation and protection of agricultural land and systems

The aim of these policies is to encourage the public, communities, and private sector, to take part in understanding, protecting and taking ownership of water resources in their vicinity, to empower the general public on Integrated Water Resources Management (IWRM), to contribute in improving water quality and the state of river health, through community monitoring creating evidence for decision making, and to contribute to skills development, and drive the water saving message.

The Department of Water and Sanitation is the mandated national agency to work in line with the Sustainable Development Goals (SDGs) in particular it is responsible for SDG 6 (Water and Sanitation) on behalf of the country. The Citizen Science monitoring programme contributes to two of the 11 SDG 6 target namely:

SDG 6.b.1: Participation of local community in water and sanitation management

SDG 6.3.2: Ambient Water Quality

- SDG 6 Target 6B1 advocates for platforms to engage and ensure the participation of local communities in the water resource management and an indicator has been developed to measure the performance of community involvement.
- SDG Target 6.3.2 Data generated through Citizen Science initiatives or monitoring can also be used to provide information on ambient water quality as part of level 2 reporting.

Two examples of this policy in action are the initiatives “Adopt a river” and “Diamonds on the soles of their feet”. “Adopt a River “ addresses the above policy targets and “Diamonds on the soles of their feet” is an example of policy enacted, using citizen science for groundwater monitoring in the Limpopo Province. This works with youth structures, schools and youth clubs, and the DWS, monitoring groundwater in wells and Adopts a River (as per the DWS project) with youth ambassadors.

5 - Useful links

Zooniverse is an online community, where citizens can take part in, and contribute to, over fifty online citizen science projects.

The '**Projects' page on the eu-citizen.science platform** contains a detailed database of European citizen science initiatives, allowing users to see key information about these projects.

SciStarter is a website that brings together all actors interested in citizen science, by hosting a database of citizen science projects, and tools and guidance for the implementation of initiatives.

The **WeObserve Cookbook** is a guide to support Citizen Observatory practitioners to access resources that can help them in setting up and/or running a Citizen Observatory.

The **CitieS-Health Toolkit** is an interactive collection of adaptable tools and methodologies for citizen science practitioners to engage communities to solve environmental and health-related issues.

The **MICS platform** allows citizen science practitioners to assess the impact of a citizen science project, while also offering guidance on impact assessment and co-design.

Community Science Exchange is an international platform for sharing best practices, resources, and outcomes to expand the reach of community science.

An integrated systemic approach to facilitate Open Science 2030 in the Netherlands

The repository of reports from the European Commission Mutual Learning Exercise on Citizen Science Initiatives- Policy and Practice contains recommendations to Member States on establishing enabling environments that support and promote good practices and impacts, relevance and excellence, and can scale up Citizen Science.

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