

Chapter 18

Citizen Science and Policy



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Abstract Citizen science has manifold relationships to policy, which is understood as sets of ideas or plans for action followed by a government, business, political party, or group of people. In this chapter, we focus on the relationship between citizen science, government policies, and the related notions of politics and polity. We discuss two core areas of interaction between citizen science and policy. Firstly, government policies can support citizen science to flourish, for example, through legitimisation or funding. Secondly, citizen science can contribute to policymaking at various stages of the policy cycle, including policy preparation, formulation, implementation, monitoring, and evaluation. Since both of these perspectives are intertwined, the policy landscape related to citizen science is complex, and it is continuously evolving. This chapter disentangles some of the complexities, with a particular focus on the European landscape, its geographic diversity, and key players (stakeholders and beneficiaries). It presents a brief history and the current context and also includes recommendations for the future with respect to governance, policy

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impact, sustainability of citizen science initiatives, and the role of digital transformations. We showcase the pathways of leading examples but also highlight currently unanswered questions.

Keywords Policymaking · Policy cycle · Public participation · Policy impact · Research policy

Introduction

The relationships between citizen science and policy are rich and manifold. We will introduce the context of these relationships and unfold their inherent complexities throughout this chapter. Here, we will particularly focus on governmental policies, which are understood as sets of ideas or a plan for action followed by a government. On the one hand, we will introduce the characteristics of (governmental) policy that might either enable or hinder citizen science. On the other hand, we will also investigate key features that make citizen science valuable for policy and also those that might make policy uptake more challenging.

Following the overall context of this volume, we will focus on the COST context, which is primarily concerned with Europe, with a few links to the global setting and comparison with countries in other regions. This will illustrate several common European interests but also the diversity of national contexts, as well as differences in local needs.

As recently elaborated by Göbel et al. (2019), citizen science can play different roles in governance, which is understood as the intention to control and direct the public business of a country, city, group of people, etc. According to the authors, there are four roles for citizen science in policy: as a source of information for policymaking, as an object of research policy, as a policy instrument, or as a form of sociotechnical governance (i.e. a form of direct governance via non-policy actors).

The relationships between citizen science and policy can, for example, be explained by applying the framework of the Sustainable Development Goals (SDGs). A recent article by Fritz et al. (2019) detailed the possible benefits of citizen science data for the monitoring of the SDGs, that is, as *a source of information for policymaking*. Additional contributions to the global policy on sustainable development can be made by citizen science contributions to the quality assurance and analysis of data, the co-development of indicators, and much more. SDG 17, ‘Partnerships for the goals: Strengthen the means of implementation and revitalize the global partnership for sustainable development’, provides a policy frame that supports public engagement in scientific research, which could include citizen science, both as *an object of (research) policy* and as *a policy instrument*. Citizen science activities supporting sustainable living (e.g. numerous citizen observatories in areas such as transport, agricultural production, and noise pollution; see also WeObserve 2019) contribute *sociotechnical* change to the sustainability transition. This type of engagement substantiates one of the most famous phrases related to the SDG framework: *think global, act local*.

In this chapter, we will address the topic of sociotechnical governance only as far as government policies might affect this topic (both positively and negatively). We will distinguish between policy for citizen science (the contributions government policy might make to citizen science) and citizen science for policy (the contributions that citizen science can make to government policy) – and the interplay between these two sides of the same coin. We focus on matters related to citizen science, which overlap with, yet are different from, other concepts, such as citizen initiatives that engage citizens directly in policymaking. Elaborations on citizen initiatives and governments are, for example, provided by Mees et al. (2019) – here in the context of climate change adaptation.

The remainder of the chapter will present a detailed background of the relationships between various interpretations of citizen science and different areas of policy, followed by an elaboration of the current situation. On this basis, we will distil some of the most pressing challenges that we see at the interface between citizen science and policy today. We will conclude by outlining emerging trends and recommending possible actions to foster and build on existing relationships.

Background

Awareness of the potential value of citizen science for science, as well as its scientific and sociopolitical implications, was first formulated – publicly and explicitly – in the field of European environmental policies in 2008 (Haklay 2015). Today, citizen science increasingly influences science and science policy.

Underlying Structures

Public authorities may play different roles in governmental policy – including its proposal, negotiation and agreement, implementation, compliance assurance, and more. Hence, we will not restrict our discussion by simplifying policy and policymakers to a single role. There is no such thing as a single type of policymaker. We can distinguish multiple ways in which citizen science is carried out, or facilitated, by governmental institutions, including initiating supporting policies, managing research projects, practicing citizen science and engagement, researching citizen science governance and methods, and providing internal guidance and training. Figueiredo Nascimento and others already specified these roles and mapped them to different services of the European Commission in *Citizen Engagement in Science and Policy-Making* (Figueiredo Nascimento et al. 2016). Notably, this is complemented by opportunities with other public authorities, such as the use of citizen science in courts (see, for example, Brett 2017). Focusing on the area of policymaking, possible contributions of citizen science can be understood along the well-established policy cycle. Accordingly, citizen science can provide valuable

contributions to policy anticipation (agenda setting), formulation, implementation, monitoring, and evaluation (Bio Innovation Service 2018; Turbé et al. 2019).

We should also recognise the dimension of politics. Politics (a concept related to agents, processes, and resources for general interest) and policies (related to objectives, targets, and instruments) are clearly two different but closely entangled concepts (Lange et al. 2013). In this chapter, we will primarily address the relationship between citizen science and policy – without losing sight of the close relationship of these two notions with the notion of politics. For example, citizen science, paired with scientific evidence, can be a tool to create political pressure, as examples in biodiversity (especially insects; see Schmitt 2017) and air quality have clearly shown (Van Brussel and Huyse 2019). The philosophical notion of ‘the political’, that is, what is related to general interest, as research is, should be also kept in mind. Citizen science is a practice that promotes the development and exercise of different capacities and responsibilities regarding research by all members of society.

Last, but not least, all of these evolving relationships between policy and citizen science depend strongly on what is considered, perceived, or advocated as citizen science. Haklay et al. (this volume, Chap. 2) have already introduced the challenges and approaches of defining citizen science as a generic concept. However, we need to briefly revisit and emphasise the possible interpretations of citizen science before introducing its relationships to policy. Notably, requirements for definitions (quality), criteria, and terms of reference for citizen science will depend on the purpose – in our case mostly on the policy angle under consideration. For example, the selection of proposals in response to a citizen science call will depend on the funder’s criteria of what qualifies as a citizen science project. The inclusion of an activity as part of a citizen science inventory or platform will depend on the owners of this platform – and might be in conflict with the criteria or interests of supporting funders. In both cases, *terms of reference* need to be provided, and review processes need to be put in place.

Clarifying Concepts: Policy-Politics-Polity

The term *policy* refers to the set of objectives, together with plans or programmes for action, regarding a specific aspect of collective interest, for example, the policy of a company or a specific association. In particular, when we refer to objectives, plans, or programmes at government level (local, regional, national, etc.), then we talk about *public policy*. In representative democracies, the political agents – the politicians, usually integrated in parties – will be in the main responsible for defining the different public policies (educational, scientific, fiscal, environmental, etc.) at different administrative levels. Political agents also include every non-governmental entity and every citizen who seeks to influence and/or participate in the governance of diverse public matters or those of general interest.

The discussion and theorisation about the different modes of government and citizenship – put into practice by the political agents through the policies – is the

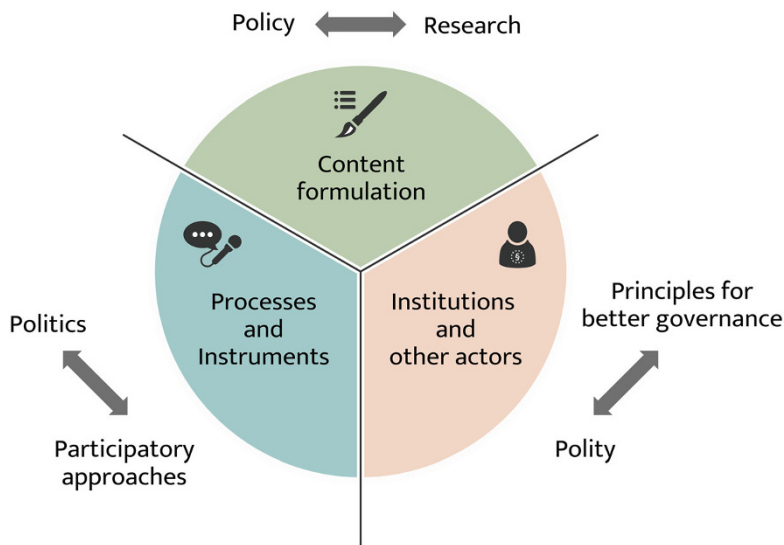


Fig. 18.1 The interdependent facets of citizen science (right) and policymaking (left) – mutual impacts

Table 18.1 Overview of the main concepts with examples and references

Concept	Key features	Examples of citizen science impacts	Literature
Policy	Content, objectives, targets	Implementation of the EC Open Science Agenda	OSPP (2018)
Polity	Formal institutions (including NGOs), principles, norms, convictions	Promotion of open and responsible research and innovation	von Schomberg and Hankins (2019)
Politics	Processes, instruments, elections, lobbying	Focused activities for more pollution regulation, influencing also election behaviour	Van Brussel and Huyse (2019)

object of *polity*. Polity is the matter of study in many social sciences, such as political sciences, political philosophy, and the philosophy of law, which ask which models and actions of government are better than others and why.

In this chapter, we are particularly interested in practical action, in *policy*, while acknowledging its interconnectedness with ‘polity’ and ‘politics’. The links between policy, polity, and politics have been extensively studied (Lange et al. 2013) and are summarised here in Fig. 18.1 and Table 18.1. Furthermore, we note, with Irure (2002), that developing and implementing a policy are a multistage process in which the role of active citizenship can be truly relevant. First, a need is identified. After deliberation and the analysis of resources, the issue is introduced into the government agenda. Then, the objectives are defined, and the strategies to achieve them are designed, together with the indicators needed to measure the results. At the same

time, competent agents are sought who will develop the implementation and fulfilment of that policy. It seems necessary, thus, to understand the relations between citizen science and policies and to understand the need to take into account the knowledge of all experts – inside and outside academic and political institutions – both when identifying problems and when making decisions, as well as when carrying out programmes and monitoring them.

We understand that the development of citizen science – usually in bottom-up projects but not limited to them – is indissoluble of its influence, greater or lesser, in the development of various policies. This is also what we intend to show in this chapter.

The Development of Citizen Science and Policies

The development of citizen science, together with its presence in European policies, can be framed in a broader context, related to the so-called participatory turn (Jasanoff 2003) that developed mainly in the 1980s and 1990s. Such a context is reflected in a democratisation of very different areas of society, which involves increased awareness and acceptance of responsibility (von Schomberg 2011) and the necessity of common deliberation on common issues (MacIntyre 2016). While such participation has been developed in practical contexts, its different forms and meanings, as well as its diverse social and political implications, have been comprehensively analysed, including warnings and/or complaints about the instrumentalist interests behind the promotion of citizen participation (De Marchi et al. 2001; Mirowski 2018).

In this section, we briefly present the evolution of policies in Europe related to citizen science. We address European policy support for the funding of citizen science activities, before shifting our focus to the political agenda and the development of participatory aspects with regard to citizen science (both outlining the policy for citizen science perspective). Finally, we highlight the contributory aspects of citizen science in policy-related actions (citizen science for policy perspective).

Citizen Science and European Research Funding

The already mentioned participatory turn is indeed soundly reflected in European policies, which have incorporated notions related to citizen science from diverse sources, including (1) political and economic sciences, *co-production* (Ostrom and Ostrom 1977); (2) the sociology of science, *co-production of knowledge* (Jasanoff 2003); (3) scientific governance, the *lay-expert* relationship (Irwin and Wynne 1996); and, recently, (4) the philosophy of science, the notion of *responsible research and innovation* (RRI) (von Schomberg 2011). RRI was first introduced in the Seventh Framework Programme (FP7) for funding European Union research

and development, and integrated as a cross-cutting agenda in its successor, Horizon 2020, forming a primary focus of the ‘Science with and for Society’ (SwafS) stream of the programme.

Interestingly, within and beyond the original RRI/SwafS agenda, a great number of European projects using a citizen science methodology, with a multidisciplinary and transdisciplinary approach, have been or are being funded following FP7. Many RRI-related projects have involved the dissemination of the concept of participation, often including the promotion of citizen science and, more recently, do it yourself (DiY) activities as a further step in public participation, beyond activities that encourage greater dialogue between all concerned, such as science shops.

The idea of co-production or *co-creation* has been present over the last few decades and now appears – under the notion of *codesign* – in the preliminary documentation of Horizon Europe (EC 2018a). In fact, these notions not only are a trend in the research and innovation area but also underpin an increasingly general vision for improving European governance (EC 2018b) – a vision already established in the white paper *Europe 2000*, through notions such as co-regulatory mechanisms, cooperation, coordination, and co-decision, all in order ‘to connect Europe with its citizens, as the starting condition for more effective and relevant policies’ (EC 2001a). Vohland et al. (this volume, Chap. 3) provide additional information about European research funding.

Citizen Science Beyond Research Funding

In citizen science, terms such as co-production and co-creation have often been used, not just in relation to implications in decision-making and consultation with citizens but alongside them, to achieve active involvement in all the steps of the research cycle. Cooper and Lewenstein (2016) have explained how the two different visions of citizen science – Irwin’s, closer to activism and social-political demands (Irwin 1995), and Bonney’s, more linked to the contribution of scientific data by citizens (Bonney 1996) – need not be two distant visions.

In this section, we also offer some more remote precedents of this participatory turn, which has led to citizen science development alongside different policies, not only in environmental areas but also in many other such as health and more recently in the digital realm, all in the context of the evolution of democracy in European countries.

Firstly, the *right to science* (Wyndham and WeigersVitulo 2018) was established in the framework of human rights, as the ‘right to share in scientific advancement and its benefits’ (Art. 27 in UN 1948) and, then more specifically, in the framework of social and cultural rights (Art. 15 in UN 1966). Until the last two decades, this had been mainly understood as the right to access information and knowledge, as well as the benefits of different scientific and technological developments. By the end of the twentieth century, this understanding had already evolved ‘from the right to access information and knowledge to the right to participate’ (De Marchi et al. 2001),

mainly through decision-making regarding risk in environmental and health issues. However, it is true that a citizenry interested in sharing in scientific progress was also being formed, a citizenry capable not only of accessing but also of generating scientific knowledge.

In addition, and also on a global scale, demands for more sustainable development have fostered citizen participation in the field of environmental conservation, significantly since the United Nations Conference on Environment and Development, known at the 'Earth Summit' or 'Rio 92'. It should be remembered that the origins of *sustainable development* as a concept go back further due to a confluence of different factors, among others, the impact of Rachel Carson's dissemination work that led to the formulation of environmental policies around the world and the notion of a *principle of responsibility* towards future generations (Jonas 1984), which was also key in the emergence of the (controversial, but currently applied) *precautionary principle*.

In this context, the well-known texts by Irwin (1995) and Irwin and Wynne (1996) are useful. These authors, among many others, claim the recognition of supposedly non-expert knowledge – providing empirical examples – mainly with respect to decision-making in the area of environmental and health-related risks, which are linked to scientific-technological development. The right to participate in environmental decision-making was granted in 1998 by the United Nations Economic Commission for Europe when it adopted the Aarhus Convention. But a major step was taken when, as Muki Haklay (2015, p. 17) points out, the 'National and multinational environmental policy demonstrated, an awareness of citizen science, in particular in a speech in 2008 by Professor Jacqueline McGlade, then Executive Director of the European Environment Agency (EEA)', who announced the creation of a Global Citizens' Observatory for Environmental Change, starting with the integration of citizens' observations with official water quality data. She noted that many times people closest to the problems can give the best information and their own vision to complement the official information, highlighting the importance of taking advantage of this local knowledge.

The Bigger Picture

It is worth now remembering Irwin's rationale for focusing on environmental and health risks (1995). Among other reasons, he indicates that these issues represent other areas of social and technical debate. In fact, a few years after publication, the documents related to the creation of the European Research Area (ERA) in 2000 clearly mention 'openness, participation, accountability, effectiveness and coherence' (EC 2001a, p. 8) and the 'participation of civil society' in science and technology policies (EC 2001b, p. 14), even though they do not explicitly use the term 'citizen science'. Gradually, participation is increasingly understood in a more active and all-embracing way, including participation in all stages of the scientific process.

In fact, specific reports on citizen science and environmental policies have been published by the European Commission. *The Science for Environment Policy In-depth Report: Environmental Citizen Science* offers a comprehensive picture of environmental citizen science in Europe (EC 2013). The report explores research into citizen science and provides a wide range of citizen science projects showing the variety of approaches and topics covered. By emphasising the so-called contributory projects (designed by scientists but relying on volunteers to collect data), mostly in the environmental field, it reveals the potential added value of such projects and their benefits to society, science, and policy decision-making that still need to be evaluated. Benefits include large data sets for science, an increase in public engagement and interest in research and policy, and the improvement of policy decision-making by including various sources of knowledge and by providing evidence to support regulatory compliance and inform policymaking.

Building on the 2013 In-Depth Report (EC 2013), the report *Citizen Science for Environmental Policy: Development of an EU-wide Inventory and Analysis of Selected Practices* (Bio Innovation Service 2018) undertook a wider survey of studies and provides further insights into the relevance and usefulness of citizen science for environmental policy. The two main aims were to create an inventory of environmental citizen science projects relevant for environmental policy and assess how these projects contribute to the Sustainable Development Goals (SDGs) set by the United Nations (UN) General Assembly (UN 2015).

While the inventory affirms the predominance of contributory projects in environmental citizen science, it also points out that citizen science is covering all engagement types including collaborative (i.e. designed by scientists with volunteers contributing) and co-created (i.e. scientists and volunteers collaborate throughout all stages of the scientific process) projects in all fields of environmental sciences (Bio Innovation Service 2018). The report found that environment-related SDGs are currently unevenly represented by citizen science projects. For example, citizen science projects in the inventory contribute less to goals with a strong socio-economic focus, while marine and terrestrial nature conservation are the goals that received the best direct contribution from citizen science projects – given a predominance of monitoring citizen science projects. For the uptake of citizen science project outcomes (including data), the report identifies the importance of governments to be involved in projects from inception. Among other key results, it also shows the crucial role of NGOs in the governance of citizen science projects, while scientific excellence also increases the extent of policy use of citizen science data. The report closes with recommendations regarding the operability of citizen science projects and data management, as well as capacity building in the field of citizen science, including stakeholders from science, society, and policy. It laid the grounds for the recently published European Commission Staff Working Document on best practices in citizen science for environmental reporting (EC 2020a).

Together with these more visible examples, there are many other reports in specific fields – such as agriculture, invasive species, land use, fisheries, etc. – in which the term citizen science is not directly introduced, but the concept is present through other terms such as *participatory action research* or *community-based research* or *co-management* among many others (e.g. Nielsen and Vedsmann

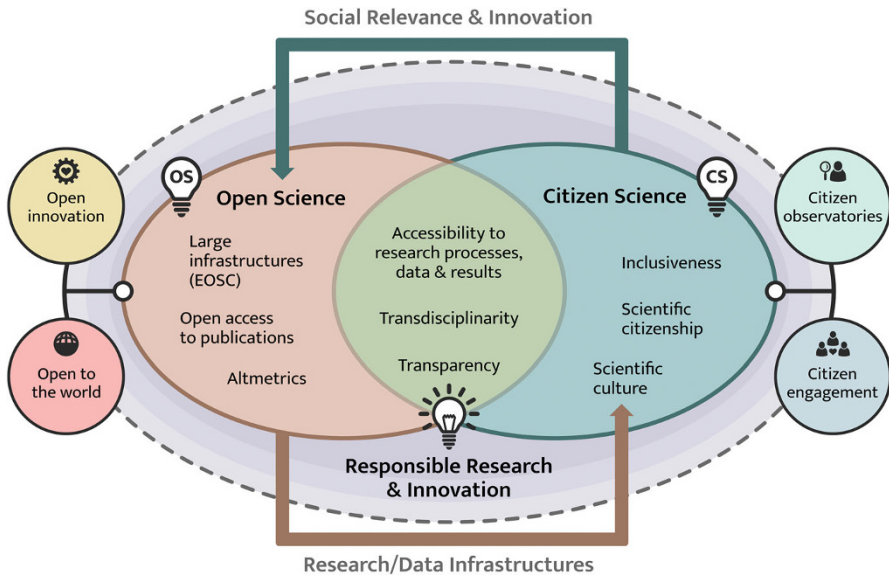


Fig. 18.2 The relationship between citizen science and open science. (Based on Vohland and Göbel (2017), modified)

(1999) show co-management as the tool for explaining the successful results in some Danish fisheries). In this sense, we could cite as examples the LIFE projects, in which citizen participation is increasingly present (LIFE Programme 2019).

Following the original Science and Society Action Plan (EC 2001b), the funding opportunities of the last three framework programmes (FPs) – ‘Science and Society’ (SaS), FP6 (2002–2006); ‘Science in Society’ (SiS), FP7 (2007–2013); and ‘Science with and for Society’ (SwafS), FP8 (2014–2020) – reflect some of this evolution, which is being widely studied both in academic papers and in policy reports (Owen et al. 2012; Rodríguez et al. 2019; EC 2016). Since 2010, citizen science has been explicitly placed in different European science policy frameworks, both aligned with the objectives of the Europe 2020 Strategy and related to more specific areas such as the Digital Agenda, Science 2.0, RRI and Open Science, and SDGs. Interestingly, the genesis of Fig. 18.2 traces back to 2010 (RIN/NESTA 2010), passing through different documents related to Science 2.0, Digital Science, and, ultimately, Open Science. It seems clear that European science policy still considers the Digital Agenda as a key route for citizen science and that European science policy is focusing on Open Science as the framework under which citizen science is justified (EC 2018a).

Today, irrespective of the different understandings and consequent definitions assigned to citizen science initiatives, the use and application of citizen science practices is increasing – at European as well as at national and local levels. This is due to a number of emerging factors, including a better understanding of the benefits stemming from the use of citizen-generated data and the increasingly economic

value attributed to them, citizen science's support of the growing phenomenon of social innovation, and the impact of digital technology on citizen science practices.

Finally, it should not be forgotten that there are many more citizen science practices not yet catalogued or even known about and that there may be thousands of people researching outside institutions, sometimes well aware of their capacities, duties, and rights: farmers, hunters, fishers, makers, hackers, and many others contribute to the growth and dissemination of knowledge, as well as to the direct or indirect formulation of policies. As some authors have explained in different ways (see, for example, Lafuente and Estalella 2015), the history of science, research, and innovation has gone through a 200-year hiatus, in which the participation of ordinary people had been excluded – but things are already changing.

Challenges

It is clear that citizen science has the potential to transform the policy landscape by generating new sources of information and by radically altering the role citizens can play in the policy process. This presents unprecedented opportunities to increase information flows, governance transparency, collaboration, and democratisation. However, many aspects of the processes that are required to generate such citizen science initiatives often do not fit within current institutional practices. Realising the potential of citizen science for policy thus requires *disruptive innovation* that challenges and changes institutional practices and leads to a dramatic shift in power relationships amongst players within the science-society-policy interface. In particular, realising a landscape in which citizen science thrives and its benefits to policy can be fully utilised requires changes within science, society, and governance.

Changes are already underway, and there are increasing signs that key actors are willing to facilitate the required disruptive innovations. However, several key challenges remain. The first two challenges address the citizen science for policy viewpoint, whereas the following two highlight issues related to policy for citizen science. The last two challenges cut across both perspectives.

Recognition of Citizen Science as a Legitimate Scientific Approach

Some sections of the scientific community remain reluctant to recognise citizen science as a legitimate scientific approach, fuelled by a lack of knowledge about citizen science opportunities, a distrust in citizen science data quality, and a preference for data collected by fellow scientists (Burgess et al. 2017). Moreover, many academic institutional practices frustrate further growth and acceptance of citizen science. Academic career paths still largely rely on having a strong publication

record in high-ranking academic journals and securing large scientific grants. Additional efforts that are needed to realize citizen science projects, including time investment in relationship building and co-creation processes with participants and policymakers, are undervalued. However, high-ranking publications and large funding grant opportunities in citizen science research are emerging. The EU investment in citizen science through the H2020 Responsible Research and Innovation Agenda has been a hugely welcomed opportunity to both advance the science of citizen science and provide career opportunities for academics specialising in citizen science approaches. Further opportunities for funding and recognition of citizen science research are needed to move citizen science further into the mainstream.

Recognition of the Value of Citizen Science to Policy

The citizen science community has long identified the benefits citizen science can bring to policy and has highlighted them to policymakers at local, national (Thornhill et al. 2016), international, and global (Fritz et al. 2019) levels. In recent years, policymakers have increasingly picked up on these benefits. The EU, in particular, has carried citizen science forward as part of its Open Science Agenda, Horizon 2020 funding programme, and numerous supportive environmental policies (see above for details).

Several EU member states have produced, or are currently developing, citizen science strategies (e.g. Germany, Austria, Italy) (Manzoni et al. 2020) or identified citizen science as a key instrument for (future) policy creation and monitoring (Schade et al. 2017). While this increasing interest is promising, funding programmes for policy-oriented citizen science remain largely limited to a few areas that have never been occupied by ‘professional science’ (e.g. biodiversity monitoring). However, significant progress has been made by some governance bodies to establish local citizen science initiatives, feeding directly into local policy implementation and resource management (Owen and Parker 2018). Outside of these areas, the benefits of citizen science remain largely theoretical for most policymakers. More real-life examples are needed to build trust among policymakers in the societal ‘return on investment’ and to fully understand the practical opportunities and constraints. Moreover, policymakers may be reluctant to invest in citizen science as long as it is not yet well known and appreciated by academia and the wider public. It can be expected that greater knowledge and appreciation of citizen science among academia and the public will facilitate greater uptake of citizen science among policymakers.

Building Trust Among Diverse Publics

The success and high uptake of various existing citizen science programmes (e.g. Van Brussel and Huyse 2019) demonstrates that there is a public appetite for citizen science approaches and that there is further opportunity for growth and

involvement across a range of demographic groups. Making a difference to science or the (local) environment and its acknowledgement by policymakers are key motivations of participants in environmental citizen science projects. It can therefore be expected that the uptake of policy-relevant citizen science projects will depend on the public's confidence in whether the outcomes will lead to actual change. This puts a clear responsibility on citizen science practitioners to manage participants' expectations and not overpromise the impact an initiative will have. Where policymakers are directly involved in the organisation of a project, they have a responsibility to set clear expectations from the outset and to live up to them, even if the evidence that emerges from the project does not suit their (political) aspirations. If public trust is broken in one (high-profile) example, it has the potential to have lasting negative repercussions on projects elsewhere. This is mirrored in the criticism citizen science has received as being an instrumentalist practice, for example, aimed at cutting and outsourcing costs (Mirowski 2018). Especially if policymakers want to reap the wider benefits of citizen science (beyond access to new data sources), including transparency and democratisation of the policy process, then they need to take citizens seriously and work together to realise common goals.

Setting up such direct collaboration between citizens and policymakers will require a pre-existing level of trust. Where levels of trust between citizens and governmental institutions are not yet sufficient, independent third parties, for example, NGOs, may play a key role in bringing partners together, holding them to account, and building trust between them (Manzoni et al. 2019).

Interestingly, citizen science can arise from distrust in decision-makers and can in itself trigger a meaningful dialogue based on independent data sets, increasing trust over time.

Citizen Science Policy Instruments

Bio Innovation Service (2018) demonstrated that policy use of citizen science data is greatest where policymakers have been directly involved in the citizen science initiative from conception through to dissemination. However, existing policy instruments for research and public engagement are often separate and are not adapted for the specific processes required to lead to successful citizen science initiatives. New instruments are needed to enable prolonged and deep engagement between all parties involved, in order to build trust and recognition between actors and create shared, fit-for-purpose data collection protocols. As part of the COST Action CA15212 *Citizen Science to Promote Creativity, Scientific Literacy, and Innovation Throughout Europe*,¹ under the its Working Group 3 – Improve Society-Science-Policy Interface² – a pan-European survey on citizen science strategies and

¹<https://cs-eu.net>

²<https://cs-eu.net/wgs/wg3>

initiatives in Europe was carried out over the last couple of years (Manzoni et al. 2020). From the preliminary outcomes of the survey, it emerged that citizen science practices operate in specific ecosystems, that is, in complex systems with interconnected processes and actors that strongly depend on the surrounding (cultural, social, governmental, and sectorial) contexts.

For any citizen science activity to be relevant for policy and achieve successful policy uptake, it has to be highly contextualised and adapted to the actual level of intervention. As such, given the variety of citizen science ecosystems and complexity of policy formulation, the analysis of citizen science approaches, and related impact assessment frameworks, need to be broken down into dedicated components with clearly defined functionality. In this context, citizen science also has its place in the process of co-creation of policy formulation, as a possible success factor for defining and achieving intended policy outcomes. It should be assessed how dedicated and well-adapted citizen science approaches can contribute to different policy instruments and policymaking processes (see, for example, Kieslinger et al. 2017).

Specific challenges have been identified around the timelines required for co-created citizen science, due to the potential for differences between participants (wanting change now) and policymakers (working to longer-term policy goals). Collaborations within an ever-changing context may lead to outcomes that are no longer relevant by the time projects produce them because the policy agenda has evolved in the meantime. Similarly, differences in capacities between professional and volunteer participants, for example, when they are available for meetings (during working hours or outside them), need to be addressed to produce successful collaborations (Göbel et al. 2019).

Pilot initiatives that can act as examples and enable learning among all parties are urgently needed before a given approach is ready to be scaled up. Consequently, growing too quickly can jeopardise public trust as it may lead to overhyped expectations that projects cannot yet realise.

Geographic Scales

Although the challenges identified above are relevant at all geographic scales, addressing them may differ in local, national, and international contexts. Building trust may be easier at the local level, where policymakers and members of the public can get to know each other personally. Indeed, successful examples so far seem to have been achieved particularly at the local level (e.g. Owen and Parker 2018, Van Brussel and Huyse 2019). In addition, examples such as the citizens' observatories (WeObserve 2019) can be used as pilot cases which will eventually also encourage uptake at higher geographical scales.

Societal Imbalance

In many Western societies, we can observe that societies are becoming increasingly split. That does not (only) refer to income gaps but also the *cultural hegemony* of the well-educated academically skilled proportion of the population. Currently, we observe a strong bias in participation in citizen science projects towards persons with an academic background (see, for example, Haklay 2015). If we assign citizen science political power with regard to agenda setting, data collection, and policy pressure towards specific policy agendas, participation should be much broader than currently.

The Way Ahead

Overall we see a positive trend in which citizen science is recognised in policies, and we also witness a certain degree of mainstreaming. At the European level, the forthcoming EU Research & Development programme, Horizon Europe (2021–2027), amongst other developments, calls for higher interdisciplinary, more inclusiveness, and full openness of research, and it is implementing in full its recently adopted open data strategy. In this context, citizen science approaches are recognised as being an important element in support of this strategy and for the new political priorities. However, in order to move ahead and address the central challenges identified in the previous section, we see a need for the following set of dedicated and focused actions:

- *Leading by example.* As trust between the key actors (policy, science, and society as a whole) is essential, building further trust will need to be done in concert by sharing best practice and stimulating projects that can act as examples across contexts and scales. When doing so, we should remain aware that the citizen science community tends to be biased towards academics, so special attention should be taken with regard to social groups.
- *Promoting the benefits of citizen science.* The promotion and support of citizen science from European scientific policies must be motivated by reasons such as the support of evidence of the benefits; the improvement of data and scientific methodologies, as well as the ways of sharing them; the achievement of the resources' sustainability and the scientific system itself; the increase of scientific capacities and education; the strengthening of co-responsibility and trust among all stakeholders and beneficiaries; the understanding of cooperation as a way to solve certain types of problems related to knowledge generation; and risk management, among many other aspects. Some of these notions also refer to policies in other fields, such as agricultural and food systems, health systems, education systems, industry, and business. These relationships imply that citizen science, like science, is an ecosystem and constitutes a complex set of activities, institutions, and people involved, seeking solutions to complex problems. Those

directly responsible for scientific policies must be aware of the need for new and imaginative solutions and of the role that citizen science can play – perhaps small, perhaps not – in the face of current challenges.

- *Embracing the diversity of citizen science approaches.* Building trust will rely on having shared expectations of the impact of citizen science projects and the ability of projects to realise them. This means that there is an urgent need for researchers, policymakers, and publics to better understand the different types of citizen science approaches and the impacts they can achieve (refer to van Noordwijk et al., this volume, Chap. 19). This will also have direct implications for the likelihood of guaranteeing the sustainability of initiatives and communities. Different management and funding formulas have to be provided, both in science and citizen science, including the management of public-private models, as well as the alternative models developed in many maker and hacker communities (e.g. gift economies).
- *Division of responsibilities – between public services at different administrative levels (acknowledging also national diversity), NGOs, citizens, and academics.* There is a strong role for independent partners (NGOs) to facilitate trust building between policy and public and to hold policy stakeholders to account. To truly fulfil this role, policy instruments need to be in place to ensure that NGOs can fulfil this role without fear of losing funding opportunities. In doing so, it has to be recognised that citizen science cannot resolve all issues at hand. There is a tension that the state outsources some of its duties (see Vohland et al. 2019). At the same time, science – and citizen science itself – has a role in the constitution of more cohesive and collaborative communities and societies (see also Pelacho et al., this volume, Chap. 4).
- *Citizen science education of academic community.* The success of citizen science requires education of the academic community, integration of citizen science in research training curricula, and opportunities for interaction and learning. Research funders have a particular role in stimulating debate and enabling disruptive innovation. Not all ‘open science’ approaches – within them citizen science – have the same ethical-political base; therefore different understandings of open science ought to be comprehended in order to foster good practice from an ethical-political view. Scientific policies ought to guarantee that science is not instrumentalised in a negative way, even more so in citizen science and citizen scientists (professional or not), for example, through outsourcing costs. Policies can foster or support approaches to citizen science that favour a socially robust science while at the same time leading and promoting innovation.
- *Highlighting the citizen dimension in data-related policies.* In this chapter, we deliberately focused on (research) policy that fosters citizen science approaches, as well as the benefits and challenges that citizen science can bring to sectorial policies (especially environmental policy). We did not address another cross-cutting policy area that is related to the data that citizen science intentionally or unintentionally produces and the high economic value that it brings. The creation, management, and use of citizen-generated data is another large research and policy topic, which deserves dedicated attention (Berti Suman and Pierce 2018;

Fritz et al. 2019). We recommend that such investigations are carried out with a citizen science perspective, but also with the bigger picture in mind. In other words, we see a need to intensify already ongoing dialogues, in areas such as data privacy, data governance, and data ecosystems, with the citizen science community also. The sensible use of technology (e.g. artificial intelligence) will have to be carefully considered in this (digital governance) context.

- *Developing tools and incentives to broaden participation.* Participation in Western science societies does not necessarily lead to contributing to citizen science projects, but due to their variety with regard to disciplines, purpose, and requirements, they offer the public the opportunity to participate in knowledge societies. To realise this potential, a variety of measures should be introduced, starting by sensitising children in schools, linking science to everyday problems, or offering support in the technical aspects. Last but not least, as in Western societies loneliness seems to be a real problem (the UK has appointed a minister for loneliness; see Yeginsu 2018), citizen science may offer an opportunity for meaningful social contact.

Finally, citizen science was recently given a highly supportive political framework in Europe. The European Green Deal (EC 2020b), together with the priorities to push for European democracy (EC 2020c) and to make Europe fit for the digital age (EC 2020d), offers rich and supportive grounds for further explorations. Hence, we are looking forward to exciting times, where citizen science has a great opportunity to flourish and affect positive societal, economic, and environmental change. It is up to the entire citizen science community, and the entire community, to make the best of these opportunities and to continue to establish citizen science practices for the common good.

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