Chapter 3
Citizen Science in Europe

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Abstract In this chapter, we explore the landscape of citizen science across Europe, how networks have developed, and how the science of citizen science has evolved. In addition to carrying out a literature review, we analysed publicly available data from the European Commission's Community Research and Development Information

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Service (Cordis). We also extracted information from a pilot survey on citizen science strategies throughout Europe, carried out within the framework of the COST Action CA15212. Our findings are complemented by case studies from COST member countries. Finally, we offer some insights, considerations, and recommendations on developing networks, utilising the COST Action and EU-Citizen.Science as capacity building platforms.

Keywords European regions · Policy support · Institutionalisation · Research funding · ECSA · Community of practice (CoP) · Responsible research and innovation (RRI)

The Rise of Citizen Science in Europe

In Europe, the emergence of (citizen) science is strongly linked to the endeavours of a number of well-known individuals to explore the world during the Renaissance before the broader institutionalisation of science began. Leonardo da Vinci, for instance, experimented with scientifically innovative questions while making his living as an artist. Likewise, Sibylla Merian sold her drawings to raise the necessary funds for travelling to Suriname and studying insect metamorphosis. The disciplinary differentiation of research, together with the establishment of laboratory research in the twentieth century, increased the gap between institutionalised science and other parts of society, including what may be called *citizen science* (Strasser et al. 2019).

While the practices themselves are much older, citizen science as a term evolved in the 1990s. Alan Irwin (1995) claimed that science should serve the needs of society and empower citizens. Rick Bonney and colleagues also realised the value of data hidden in amateur naturalists' desks and developed strategies to make them usable for research (Brossard et al. 2005). However, it was not until 2012 that the term became renowned globally, thanks to a steep rise in the number of publications, projects, and funding schemes. Several networks of practitioners evolved worldwide (Göbel et al. 2016; Storksdieck et al. 2016). In Europe notably, early examples emerged in Austria, Germany, and Spain (Liu et al., this volume, Chap. 22); all developed alongside the cross-national European Citizen Science Association (ECSA). Moreover, the COST Action CA15212 *Citizen Science to Promote Creativity, Scientific Literacy, and Innovation throughout Europe* connected over 500 researchers and supported them in establishing a *science of citizen science*.

A Diverse Citizen Science Landscape

European countries and regions differ in many ways, the most obvious being the 24 official languages spoken across Europe. However, related to citizen science practice, additional differences can be identified: socio-geographical differences, such as the degree of individualism versus collectivity espoused; political

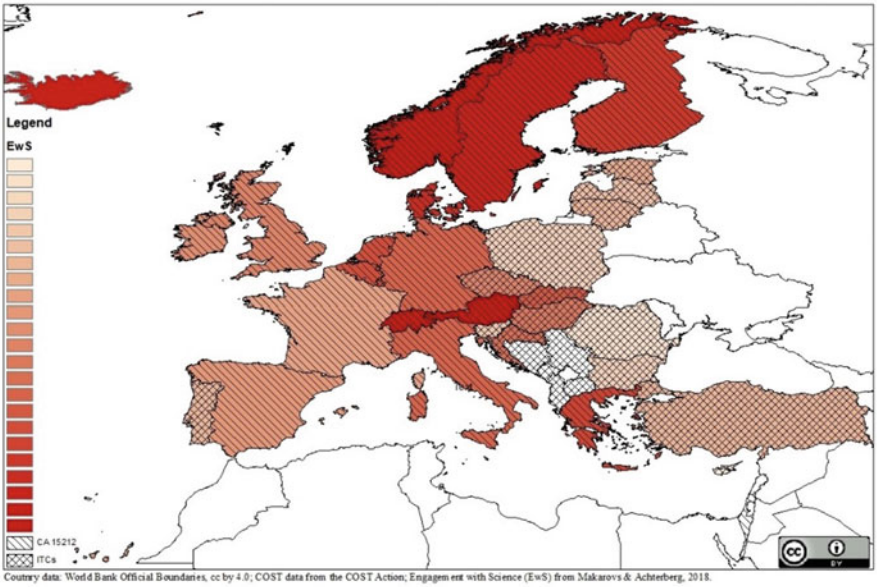

Fig. 3.1 Engagement with Science (EwS) in Europe indicator, based on data from Table 2 (p. 36) in Makarovs and Achterberg (2018). The higher the score (indicated by a darker red), the more engaged the public is in science. The figure also shows the countries who are members of the COST Action CA15212. Within its funding scheme, the COST programme specifically supports the so-called Inclusiveness Target Countries (ITCs). Country data: World Bank Official Boundaries; COST data from www.cost.eu

differences regarding the level of democracy expressed; and cultural differences, such as the roles assigned to science and engagement in societal issues. Looking more closely at these factors can provide a starting point to gain deeper understanding of the diversity of the citizen science landscape in Europe. For instance, the link between democracy and public participation in research is especially salient: the analysis of data gathered within the framework of a Special Eurobarometer survey showed that countries with higher democracy indices[1] have higher rates of engagement with scientific activities (Makarovs and Achterberg 2018; Fig. 3.1).[2]

[1]The democracy index, as measured by the assessment of 60 items ranging from the election system and government's function to personal rights and engagement, revealed differences worldwide but also in Europe (EIU 2018). Most countries in Western Europe were identified as 'full democracies', albeit some countries, such as France, Belgium, and Italy, were tagged as 'flawed democracies' with some deficits in political culture and low levels of political participation. In Eastern Europe, most countries fell into that class, even if they were labelled 'hybrid regimes'. This means inter alia that 'elections have substantial irregularities that often prevent them from being both free and fair' (EIU 2018, Appendix).

[2]The indicator is based on interview data from the Special Eurobarometer survey from 2010 on Science and Technology. https://data.europa.eu/euodp/de/data/dataset/S806_73_1_EBS340

In 2016, the first large-scale online explorative survey of European citizen science was conducted. It focused on five topics: types of citizen science projects, their perceived impact, added value and challenges, current funding schemes for citizen science, and project outcomes (Hecker et al. 2018). In all, 174 citizen science project coordinators responded, mainly from Central, Western, and northern Europe (136 projects), including Austria, Belgium, Denmark, France, Germany, Ireland, Luxembourg, the Netherlands, Norway, Sweden, Switzerland, and the United Kingdom. Only 32 projects (approx. 18%) were in southern and Eastern Europe, including the Czech Republic, Greece, Italy, Lithuania, Portugal, Slovakia, Slovenia, and Spain. A regional analysis showed no significant variation in the frequency of citizen science projects in terms of different degrees of public engagement or scientific discipline. Projects across Europe predominantly contributed to the life sciences.

A second survey conducted by the European Commission, focusing on environmental policy, showed a similar pattern (Bio Innovation Service 2018): a gradient in project numbers from west to east, with the vast majority of projects linked to biodiversity research. These results were confirmed by a more recent survey carried out in 2019. It targeted mainly members of the Management Committee of the COST Action CA15212 from 31 European countries and aimed to identify citizen science strategies and initiatives in Europe (Manzoni et al. 2019). Again, this survey revealed that most citizen science activities take place in the life and environmental sciences compared to the humanities or social sciences. The presence of institutional strategies at the national level was limited to few countries, while initiators of projects were mainly scientific institutions, followed by NGOs and self-regulated communities. Funding came mainly from public administrations bodies, while the terminology used to describe these projects differed widely among the countries represented (see also Haklay et al., this volume, Chap. 2).

An increasing number of country-level reports further complement the overall picture, mostly in Western Europe, for instance, in the United Kingdom (Tweddle et al. 2012), Switzerland (science\cité 2015, Strasser and Haklay 2018), France (Houllier and Merilhou-Goudard 2016), Spain (Serrano et al. 2017), Germany, and Austria (Pettibone et al. 2017), as well as a massive citizen science biodiversity project in Portugal (Tiago et al. 2017). There are also reports for some Central and Eastern European countries, such as Latvia (Prūse and Dātava 2017) and the Czech Republic (Duží et al. 2019).

Besides realising that citizen science activities and strategies in Europe are context dependent, the above survey from Manzoni et al. (2019) also revealed several features of current European citizen science practice. It is through *communities of practice* (CoPs), networks, and shared platforms that most citizen science activities are supported. Project impact is identified, to different extents, in all segments of the hosting ecosystem, namely, at policy, scientific, economic, and social levels. The presence of dedicated plans supported by funding for long-term sustainability is a crucial influencing factor. Mutual trust and interest in common challenges proved to be core enabling conditions.

In sum, despite the different understandings and definitions assigned to citizen science initiatives, the prevalence of citizen science practices seems to be increasing both at European and national levels. This is due to several supporting factors, such as the acknowledgment of the assets stemming from the use of citizen-generated data; the perceived impact of citizen science on social innovation; and, most importantly, the mutual benefits of technology developments and citizen science practices. Nevertheless, many challenges and opportunities arise from the diversity characterising the European scene with regard to science cultures, historical differences in science and societal relations, and *research and innovation* (R&I) policy approaches.

Citizen Science in Western and Northern Europe

In countries such as Austria, Germany, and the United Kingdom, the tradition of *learned associations*, which arose in the eighteenth century, is still present today. Typically, persons who are employed in museums and research institutes meet regularly with amateur experts to organise excursions or talks and map or determine species. This tradition is still visible in current approaches. For instance, Sweden developed *Artportalen*, a platform which systematically integrates citizen science in national biodiversity reporting. Aided by European funding and emerging networks, citizens increasingly contribute to gathering localised data which can be used for geographic applications (Trojan et al. 2019).

In Germany and Austria, governments see citizen science as a means to involve the general public in science to increase scientific literacy as well as to foster innovation (BMBF 2019; Box 3.1). For instance, in Germany, the Federal Ministry for Education and Research (BMBF) supported citizen science by funding a 2-year national strategic process and a citizen science capacity building programme, in 2014–2016, to assess the opportunities and challenges of citizen science. Citizens, civil society organisations, scientific institutions, and researchers from all fields contributed to the enhancement of citizen science in a programme that built on dialogue and participation. This resulted in a national strategy for citizen science, community building, and the platform *Bürger schaffen Wissen* (CitizensCreateKnowledge) which hosts more than 100 projects from diverse disciplines (Pettibone et al. 2017). In the context of these developments, the Federal Ministry also initiated a funding programme for citizen science projects with two calls for supporting citizen science projects (in 2017 and 2019). Key challenges also lay in the structures and incentives of the scientific system. In Germany, especially, non-university research institutes, such as members of the Leibniz and Helmholtz Associations, run citizen science projects. Some universities adopted the citizen science approach as a tool to fulfil requirements for knowledge transfer or the so-called Third Mission. Austria has a comparable national citizen science platform, *Österreich forscht*, and also provides government funding; however it is more associated with educational activities (Box 3.1).

Box 3.1: Sparkling Science in Austria
The Austrian Federal Ministry of Education, Science and Research (BMBWF) initiated a funding programme called Sparkling Science to support projects where pupils at all education levels work together with scientists in the research process. The project started in 2007 and will end in 2020. Since 2007, 299 projects have been funded at a total cost of about 35 million Euros. The projects covered various research areas (natural sciences 30%, social sciences 20%, technology 12%, teaching and learning research 12%, informatics 11%, humanities 9%, medicine and health 6%) and directly involved 198 research institutions, 28,935 pupils, and 1947 teachers (Sparkling Science 2018). The programme selects projects that take into account the state of the art in science and in which pupils work with researchers towards the achievement of the project's specific research goals. Moreover, pupils' contributions are embedded in a way that the project results comply with scientific quality standards.

Citizen Science in Central and Eastern Europe

Compared to north-western or south-western European countries, Central and Eastern European regions followed different historical trajectories in the relationship between science and society (Mejlgaard et al. 2019). This is reflected in science's general role and responsibilities in society (see, e.g. the MASIS project) in Central and Eastern European (CEE) countries and their shared experience of belonging to, or depending on, the Soviet Union for several decades. This heritage is also illustrated in the organisation of the scientific system with core disciplinary foci gathering around physics and chemistry rather than sociology or environmental issues, or in the low level of outreach activities (Kozlowski et al. 1999).

Citizen science practices emerged as a novelty from the West, but volunteerism has quite a long tradition, and many amateur or professional initiatives contain socially innovative elements that could be seen as prefigurations of citizen science (see also Butkevičienė et al., this volume, Chap. 16) and involve citizens and crowdsourcing in semi-scientific or civic projects. Typically, people join, as volunteers, initiatives in biodiversity monitoring, nature protection (e.g. Box 3.2), and ornithology. However, there are also small-scale civic or public institution-led initiatives in mapping geography, soil science, water quality, and air pollution.

Although there appears to be less evidence of citizen science projects in the CEE region, this may be due to unequal knowledge production in several aspects. For example, language barriers may cause lower representation of non-English citizen science projects (Bio Innovation Service 2018); or monitoring of internal and international activity might be less frequent, as indicated by Hecker et al. (2018).

Citizen science in CEE countries can be characterised as a 'hidden citizen science landscape' (Duží et al. 2019, p. 243): engagement in individually led or participatory research is given recognition or defined as citizen science. The relatively undervalued role of citizen science within the R&I sector is another aspect. Recently, however, international cooperation is developing, thanks to scientific projects, and membership in international citizen science associations (ECSA, CA15212, and others) is leading to increased knowledge about citizen science in CEE countries.

For example, in the Czech Republic, citizen science (*občanská věda*) has made progress, including a higher rate of cooperation between academia and NGOs, a greater popularisation of the practice, and the amplification of citizen science projects, primarily via the Czech Academy of Sciences and NGOs (e.g. Czech Ornithological Society; Duží et al. 2019). Moreover, citizen science is now part of one university's curriculum. However, despite a flourishing environment for citizen science (predominantly in the natural sciences, nature protection, and ornithology) and civic participation projects in general, there was no corresponding response at government and political levels (as represented in official documents, individual grant schema, etc.). Current developments indicate that positive progress will continue, including an increased level of international cooperation at European level (e.g. ECSA, COST Actions).

In Lithuania, citizen science as a term (*piliečių mokslas*) emerged in the public discourse only recently, although it is still not well established. Even though the social media and news bulletins present stories and experiences of citizen scientists from other countries, at the policy level, citizen science lacks recognition. Nevertheless, there are several projects in Lithuania that can be classified as citizen science, for example, *Rūšių ralis* (Species Rally), aimed at both natural science professionals and nature lovers, and *Bronės Pajiedaitės takais* ('On Brone Pajiedaite's path'), a project on Bryozoan biodiversity monitoring.

Box 3.2: Wilderness Ranger in Hungary

In Hungary, 10 years ago, a biodiversity monitoring citizen science project began under the auspices of the Agricultural Ministry's nature conservation department. Their programme called *Vadonleső* (Wilderness Ranger) invites citizens to participate in protected species conservation, conservation-oriented data gathering, and practical nature conservation. Within this period, 12,000 people have participated in gathering data about 18 protected species. However, no strategies or policy documents have been created based on this initiative to further support citizen science practice. Citizen science remains largely unacknowledged by research funding. However, small-scale projects are available in academic institutions and NGOs.

Citizen Science in Southern Europe and the Balkans

The economic development of countries in southern Europe and the Balkans was somewhat delayed compared to most northern and Western European countries. Political stability and democratic institutions were undermined by varying periods of dictatorship over the course of the twentieth century, and they have all faced some kind of financial crisis at the beginning of the twenty-first.

An exploratory desktop survey conducted for the needs of this report allows us to make some preliminary remarks on the rapidly growing trends of citizen science in southern Europe. One of them reveals a greater emphasis of most projects on public participation through sensing and monitoring projects, mainly with a focus on biodiversity topics. Citizens are asked to participate through making observations and collecting data with the use of different apps. While most of the projects are active mainly on a local or national scale, a great number of them are part of wider European EC-funded initiatives. The majority of the activities address the general public. A few of them target more specialised groups, such as school communities (teachers and students) or particular audiences (e.g. hunters, divers, etc.). Citizen science projects are organised and coordinated either by university organisations and research centres or by other types of organisations, such as foundations, associations, and NGOs.

Spain is one noticeable southern European country where citizen science has been flourishing in the last decade. Spain can compete on equal terms with some of the leading northern and Western European countries in the field. The trend is towards a growing development of citizen science in a decentralised manner, with multiple educational, social, and economic impacts. Spain stands out as one of the countries with numerous diverse citizen science initiatives, many of them with an international perspective (e.g. Box 3.3). A significant endeavour has begun recently under Fundación Ibercivis to create a Citizen Science Observatory (*Ciencia Ciudadana en España*) and to map all related activities in an online repository. It comprises almost 200 Spanish citizen science projects and actors distributed throughout the country and covering a range of topics and scientific fields. A total of 23.8% of all initiatives are centred on biodiversity and environmental issues, 18.5% on ICT challenges, 16.9% on health and biotechnology topics, and 11.5% on the social sciences and the humanities (Serrano et al. 2017). Almost half of the registered activities are linked to international and European projects, while one-fourth of them are national, and far fewer have a local scope. More than 25% of the reported activities are research based.

Box 3.3: Natusfera and the European Open Science Cloud

One example of the current citizen science activity in Spain is *Natusfera*, a citizen science platform created by the Ecological and Forestry Applications Research Centre (CREAF) and coordinated by the Spanish branch of the

(continued)

Box 3.3 (continued)
Global Biodiversity Information Facility (GBIF) under the Spanish National Research Council (CSIC). It consists of a web portal and an app for mobile devices, allowing any citizen who is interested in creating and sharing nature-based observations, meeting other naturalists, or learning about biodiversity species to sign up, download the app, and start creating their own projects or virtual field notebooks. *Natusfera* is the first platform supported by ECSA to become available to any European group wanting to run and engage in biodiversity projects for and with citizens. To this end, it will be translated into as many European languages as possible. So far, more than 12,000 users have engaged with the platform, and more than 234,000 observations have been recorded on almost 12,000 species, mainly throughout Spain but also in other European countries. *Natusfera* is also among the European Biodiversity Citizen Science Observatories that participate in COS4CLOUD – an EC-funded project, involving 14 European partners (and 1 South American) to design services that address *open science* challenges and integrate citizen science data in the European Open Science Cloud (EOSC). The project's aim is to make European citizen science practices related to biodiversity and environmental quality monitoring more user oriented; to engage a wider range of stakeholders in society, government, industry, academia, agencies, and research; and to develop new citizen science projects and approaches by engaging new audiences, especially youths and school students, in research procedures.

In contrast to Spain, Greece is a southern European country where citizen science is in its infancy and hard to define. The first groups of citizens and Greek-based NGOs who were involved in citizen science projects date back to 2008. However, the outbreak of economic crisis in Greece the same year was decisive in shaping future trends in the field. The financial recession and the accompanying austerity measures triggered a host of dire changes in Greek society, including a considerable decrease in GDP and a high rate of unemployment, especially among young people. Public participation in the civil society and formal volunteering actions in the post-dictatorial period have been rather weak, due to the dominant role of the state. The onset of the Greek crisis brought about a significant shift in responsibility and action, mainly directed towards social welfare and assistance to the most vulnerable social groups. Public participation and citizens volunteering for other causes (e.g. for fulfilling personal learning interests) would not come first in a row of more pressing priorities. However, even in this ambiguous context, citizen science found fertile soil to grow in Greece.

Out of the 21 Greek citizen science projects that have been tracked, 7 form part of larger European projects (the Scent project, LIFE Euroturtles, Marine LitterWatch, GROW Observatory, the PLUGGY project, iNaturalist, and Project Noah), while the rest have been initiated on a national or local scale. Almost half of the projects are

run by Greek-based NGOs with a longstanding tradition in the organisation of science-focused and/or culture-oriented activities, while the rest have been established and operate under national research institutions and scientific associations. There is only one case of an international citizen science project supported and coordinated by a large private company (the Sea Hero Quest project by Cosmote). More than half of the projects and initiatives are linked to biodiversity topics (i.e. marine biodiversity, alien species, fauna, and ornithology).

The Balkans form a distinct European region with a strategic geopolitical position. Extending from the Adriatic to the Mediterranean Sea and from the Marmara to the Black Sea, they stand at a crossroads through Europe and from Europe to Asia. Balkan countries share historical–political roots and cultural features, long-lasting ethnic conflicts, and some more recent severe outbreaks of war. None of them participated directly in the big sociopolitical and economic transformations that took place in Western Europe in the nineteenth and twentieth centuries. For most Balkan countries, state identities and democratic functioning have been greatly affected by long-time communist regimes. Only a few of them are official members of the EU.

Although there are some national projects, almost one third of the identified projects are linked to larger European or global projects. These include Co-PLAN (Box 3.4) and BioNNA in Albania, the Bulgarian Society for the Protection of Birds (BSPB) and BirdLife International in Bulgaria, Association BIOM in Croatia, EwA and iNaturalist in Romania, and LIFE ARTEMIS in Slovenia. Participation in these projects targets the general public or students and is mainly for 'monitoring': citizens contribute with observations and the collection of data through the use of apps. Environmental topics, issues, and causes are the most frequent foci of interest, especially those having to do with biodiversity conservation, alien species reporting, and air pollution.

Box 3.4: Building Citizen Science Monitoring Infrastructure and Methodology in Albania

Co-PLAN is an Albanian (non-profit) organisation based in Tirana, which aims to promote 'tangible social transformation' through community participation and policymaking related to sustainable development, environmental quality, and good urban and regional governance. It works with people and institutions on both national and western Balkan regional levels but also builds collaboration in a European context. Co-PLAN focuses on exploring ways to advance citizen engagement in local governance. Through participation in the EC-funded project 'Green Lungs for our cities', it seeks to create a bottom-up monitoring platform for air quality, noise pollution, and urban greenery at the local level, in the cities of Tirana, Durrës, Elbasan, and Shkodër.

European-Level Support for Citizen Science

In addition to developments in individual European countries and regions, citizen science has received major support for the development of activities and networks at the cross-national level. The EU has played a central role, through dedicated funding for research and development of citizen science projects and capacity building activities. As an umbrella organisation of European citizen science practitioners, the ECSA functions as a community of practice, undertakes advocacy work, and links to other international networks. The COST Action CA15212 complements this picture by supporting networking for researchers working on citizen science.

EU Funding for Citizen Science

Since 2011 several citizen science projects have been supported by the EU's Seventh Framework Programme (FP7) as well as under Horizon 2020 (Table 3.1). Currently, about 234 million Euros has been allocated to projects which are somehow linked to citizen science.[3]

The highest proportion of EC funds went to Research and Innovation Actions (RIAs), while Cooperation and Support Actions (CSAs) had the second highest share. This indicates the dual nature of the institutionalisation of citizen science: on

Table 3.1 Funding of projects by the EC, assigned to the year of project start

Year of project start	Number of released projects	Amount of money invested (in €)
2011	2	14,984,790
2012	2	4,109,999
2014	4	2,161,605
2015	14	69,924,599
2016	22	62,573,965
2017	6	16,286,683
2018	19	28,618,133
2019	10	27,906,833
2020	1	7,174,252[a]
Totals	**80**	**233,740,859**

Source: Cordis database

[a]On date of retrieval, not the complete year

[3]However, these data need to be regarded with a careful eye since citizen science is a young, fuzzy, and overhyped subject. This might lead to both over- and underreporting. For instance, the project ENVRIplus (Finland) receives over 14 million Euros, but does not have 'citizen science' in its description or on its webpage and only one deliverable deals with tools for citizen science (http://www.envriplus.eu/wp-content/uploads/2015/08/D14.6.pdf). On the other hand, PANELFIT is not listed although ECSA is one of the beneficiaries.

the one hand, it is driven bottom-up, from within the scientific system by project consortia requesting funds for projects to apply (and develop) citizen science for the generation of scientific knowledge. On the other hand, there is a top-down component represented by funding that goes into projects promoting citizen science to various audiences, such as policymakers, researchers, and the public. The United Kingdom, the Netherlands, and Spain started the most projects and received the highest share of funding.

This is in accordance with Hecker et al. (2018), whose survey showed that 28% of the 32 southern and Eastern European and approximately 10% of the Western, Central, and northern European projects (a quarter of the responding projects) 'receive either no funding or less than €10,000 funding. Many projects (43%) receive between €10.000 and €250,000, while approximately a third of them (31.8%) substantial funding of over €250.000, and 14% more than €1,000,000' (Hecker et al. 2018, pp. 194–195). Project coordinators stated that this funding mostly comes from national and EU research funds, while NGOs and projects often have several sources of funding. Less than half of the project coordinators thought that the initial funding was appropriate, while only 15% viewed the long-term funding as appropriate.

Emerging European Citizen Science Networks

The European Citizen Science Association

The idea of founding ECSA as the European umbrella organisation for citizen science was largely inspired by the Open Air Laboratories (OPAL) project in the United Kingdom (Davies et al. 2011). Supported by the Big Lottery Fund UK and several other institutions, education and learning about nature was combined with the gathering of scientific data by the public. In contrast to a loose network, a legal entity (like ECSA) would allow bidding for (European) funds and provide a legitimised voice to advocate for citizen science in the political arena at the European level. Therefore, in 2012, ECSA was officially registered as an association under German law, with seven members, and based at the Museum für Naturkunde in Berlin, which still hosts it. The association grew quickly and integrated individual as well as institutional members (59 and 84, respectively, in 2019) and 10 employees together with part-time officers and students (ECSA, personal communication). To support work on citizen science projects played a major role. One of the first and most important funding sources for developing the association and citizen science in Europe was the Horizon 2020 Doing it Together Science (DITOs) project, coordinated by University College London (UCL). Later, the International Institute for Applied Systems Analysis (IIASA) in Laxenburg, Austria, invited ECSA to join successful EU project proposals, such as the LandSense and the WeObserve projects. In 2019, ECSA was a partner in seven projects, sustained by several organisations throughout Europe, including the capacity building platform EU-Citizen.

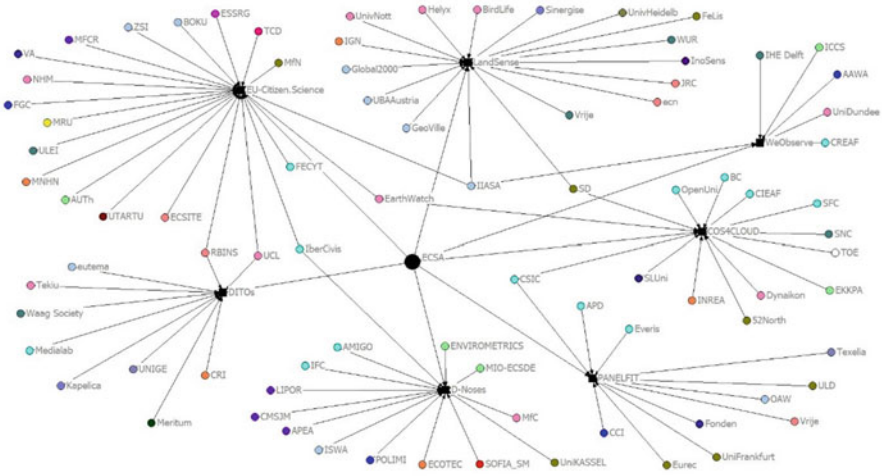

Fig. 3.2 EC projects with ECSA as beneficiary; partners from the same country are in the same colour. Source: database: https://cordis.europa.eu, date of retrieval 23 October 2019, acronyms used; Software: Ucinet (Borgatti et al. 2002)

Science (Fig. 3.2). ECSA's role varies in these projects, but includes core task such as communication, exchange between practitioners, and sharing of best practice.

Doing It Together Science (DITOs) Project

DITOs was one of first pan-European projects structuring citizen science. Its main purpose was to organise public engagement events dealing with citizen science in do-it-yourself (DIY) biology and environmental sustainability. ECSA was responsible for *policy engagement*, engaging decision-makers[4] at local, national, and EU levels to raise awareness of citizen science, to stimulate personal encounters, and to develop institutions. This work provided the opportunity to strengthen citizen science in various respects:

1. **Advancing the development of ECSA.** ECSA profited from DITOs primarily through funding for personnel at the secretariat and networking events. Beyond this, ECSA used DITOs to refine structures and community management processes in more open ways in order to be a more credible agent of integration for European citizen science communities. This approach was based on working together with practitioners from citizen science, community-based research, and

[4]Decision-makers were persons with the ability to effect change regarding citizen science and DIY science, e.g. politicians, staff of funding agencies, scientific institutions, civil society organisations, and others.

DIY science. Several round tables explored questions of inclusiveness, and ECSA launched the working group Empowerment, Inclusiveness and Equity in cooperation with the Living Knowledge Network (e.g. Göbel et al. 2019). However, building and maintaining cultures of working more openly is challenging. Such work usually takes more time than operating in less participatory and less transparent ways, staff need to be trained, and strategic commitment needs to remain a priority throughout changing leadership.

2. **Building capacity for national citizen science networks.** Through DITOs, ECSA managed to strengthen emerging national initiatives, such as the Italian citizen science community. A series of round table events were organised in 2017 and 2018 which resulted in guidelines for how to support citizen science in different sectors and at various governance levels (DITOs Consortium 2019). Cooperation with local partners, including the Italian National Academy of Sciences and the Maremma Natural History Museum, was essential. ECSA also supported national networks in Germany, the United Kingdom, France, and Spain through DITOs. If and to what extent such networks are successful in stimulating (ex)change and achieving political and financial support also depends on policy priorities – like the current push for participatory science communication in Germany (BMBF 2019).
3. **Anchoring citizen science in EU research policy.** ECSA's advocacy work in DITOs mainly addressed the Responsible Research and Innovation (RRI) and Open Science agendas. The ECSA Working Group Citizen Science and Open Science gathered good practice and recommendations, while ECSA leadership engaged with the Open Science Policy Platform, a high-level policy forum. As a result, participation and research have been better conceptualised and carried out in more significant ways. A pluralistic concept of citizen sciences, like the escalator models used in DITOs (Haklay 2018), as well as ensuring diversity of speakers and perspectives, was essential. How these activities of positioning citizen science as a relevant approach to research and science communication fit in with larger restructurings in the EU research policy agenda that is downsizing funding for public engagement (cf. Gerber 2018) is to be assessed in the future.

Challenges and Opportunities

Citizen science opens up many scientific and societal opportunities for Europe as a whole. The engagement of citizens in scientific endeavours and their contributions to scientific knowledge boost learning and personal development. Communities of citizen scientists can learn from each other and jointly strengthen the field by building networks (such as ECSA). As demonstrated in this chapter – and the rest of the present volume – each European national case is unique (i.e. in terms of its history, culture, and governance structure), and no one-size-fits-all solution appears plausible for citizen science practice. At the same time, rich and diverse possibilities

are offered for the public to become engaged and make a difference – in science, the governance of social, economic, and environmental challenges, and society at large.

However, an imbalance with regard to funding programmes and infrastructures still exists in Europe. In addition to this, countries with more engaged citizens and funded projects have the power to shape the discourse around citizen science and do advocacy work (cf. Haklay et al., this volume, Chap. 2), which strongly impacts on the understanding and future infrastructures of citizen science generally. However, it is essential to provide all European citizens with equal opportunities to participate in citizen science activities. The COST Action is such an empowering tool to address current socio-economic inequalities within and across countries. Discussions over the different terminology and disciplines as well as the history and current societal and political functions have been fostered to enrich the field, as demonstrated by the large number of reports and papers.

Recommendations for Future Developments

Today, citizen science is a growing and flourishing practice in Europe and across the world. To take advantage of this momentum, a strategic and multiscale approach is necessary. This approach rests on three pillars:

1. **Spread best practice from projects:**
   - Expand citizen science initiatives across European countries and regions, including networking, translating, and making available methodologies and tools. This way, existing solutions can be systemically adapted to culturally different settings and applied at larger geographical scales.
   - Share good practices and examples (e.g. on EU-Citizen.Science). Develop actionable toolboxes, which offer a multitude of resources directly applicable and adaptable to different contexts and needs. Increase knowledge and understanding of the pitfalls and failures to initiate learning in the field.
   - Base more structured methodologies on theory development.
2. **Link with strategic partners:**
   - Increase support for local initiatives from both existing communities of participatory research and new bottom-up and independent activities.
   - Cooperate with civil society organisations, since they are key agents for generating genuinely transformative research (see Göbel et al., this volume, Chap. 17).
   - Combine both top-down and bottom-up dimensions to strategically address the multiple geographical, cultural, political, and social factors required to realise the transformative potentials of citizen science.

3. **Anchor the citizen in research and development:**

- Develop and apply appropriate reputational mechanisms.
- Use overarching conceptual framings, such as the positioning of citizen science inside European policy priorities (e.g. Green Deal or mission-oriented research, cf. Mazzucato 2018; see also Schade et al., this volume, Chap. 18), or the global agenda of the Sustainable Development Goals (SDGs).
- Ensure capacity for training specific stakeholder groups (e.g. public authorities), and make it accessible to the different CoPs (e.g. via EU-Citizen. Science).
- Encourage knowledge transfer and innovation, including changing underlying business models, for instance, by using regional and structural funds to support currently underrepresented areas.

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