Green Paper
on Citizen Science

Citizen Science for Europe
Towards a better society of empowered citizens and enhanced research

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European Commission

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Sections

Introduction

Citizen Science

Citizen Science refers to the general public engagement in scientific research activities when citizens actively contribute to science either with their intellectual effort or surrounding knowledge or with their tools and resources.

Participants provide experimental data and facilities for researchers, raise new questions and co-create a new scientific culture. While adding value, volunteers acquire new learning and skills, and deeper understanding of the scientific work in an appealing way. As a result of this open, networked and trans-disciplinary scenario, science-society-policy interactions are improved leading to a more democratic research based on evidence-informed decision making.

This open and participatory approach is gaining a renewed impulse thanks to the digital revolution. It represents an effective scenario for many of the values of the Europe 2020 strategy and becomes relevant across many of the topics of the imminent Horizon 2020 programme, presenting potential links with other EU programmes. Outcomes vary in a wide range of values in scientific, social, economic, educational, environmental and inspirational levels.

The SOCIENTIZE Consortium is coordinating an ongoing public consultation and debate about the potential role of Citizen Science in Europe. As an intermediate result, this Green Paper presents the major themes of discussion and some of the policy recommendations that will be refined within the further White Paper on Citizen Science.

- **SECTION 1:** Presents the background, purpose and scope of this Green Paper.

- **SECTION 2:** Presents the related European policy context and the opportunities for strengthening citizen involvement in research in Europe. We analyse and align Citizen Science within Europe 2020 strategy, and the EU Framework Programme for Research and Innovation.

- **SECTION 3:** Presents the SOCIENTIZE activities carried out and methodology followed for the development of the common roadmap for Citizen Science in Europe.

- **SECTION 4:** Analyses key elements of Citizen Science which are the major discussion themes among the interested parties. Those major themes are the following:

  - Definition and scope of citizen science which support different engagement models understanding the potential, suitability, risks and linked policies implications.

  - Deployment, facilitation and sustainability for citizen science projects and coordinated activities at local, national and European scale

  - Awareness and motivation for active involvement of researchers and volunteers, developing understanding of the related challenges, drivers and barriers

  - Drivers and barriers for success, dealing with technologies that allow distributed intelligence and introducing cultural shift for opening

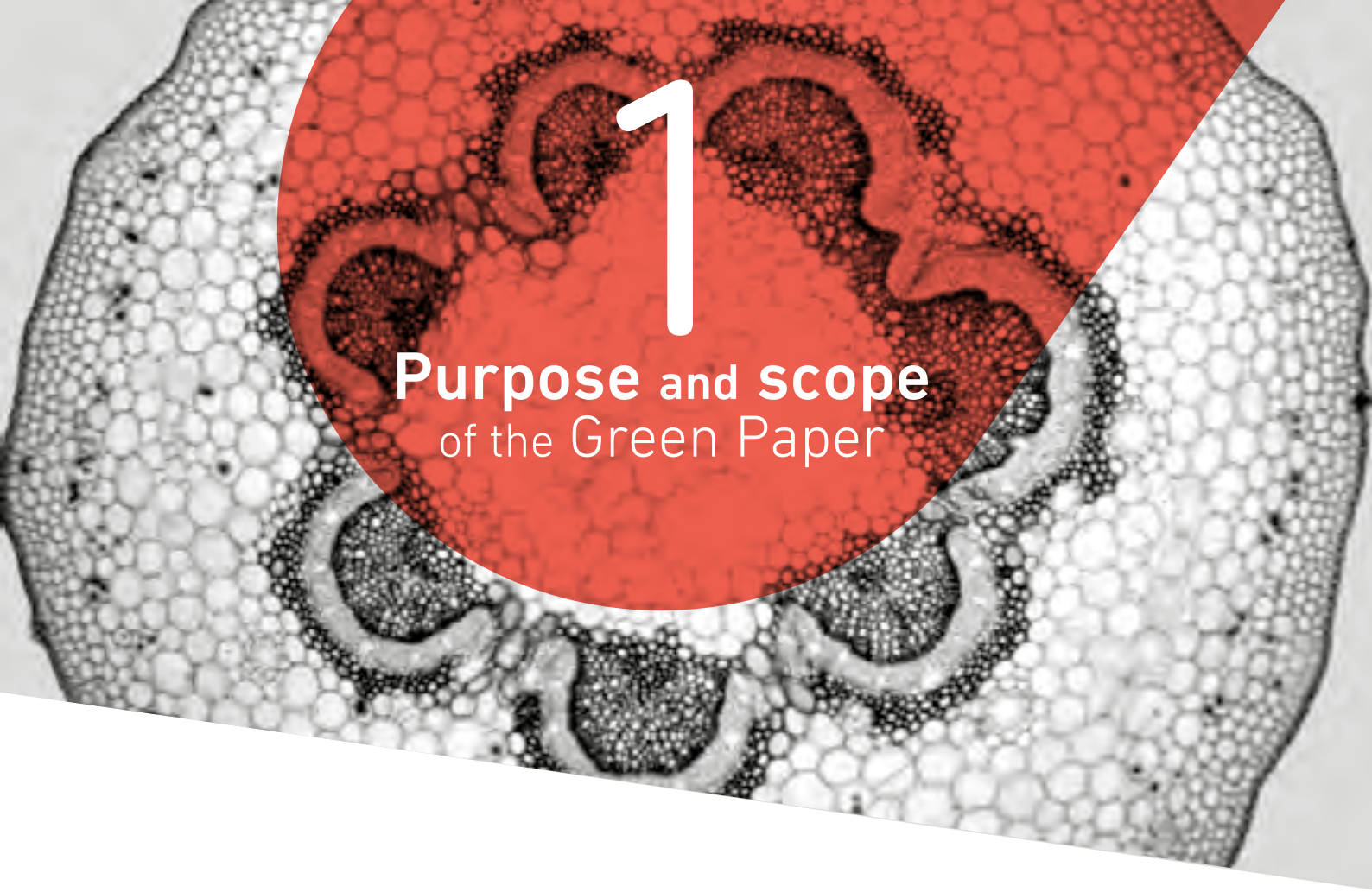
  - Impact measurement and evaluation of the different values based on trusted indicators and emerging public debate upon efficiency and excellence in science

Each section provides a description of the topics and relates these to a set of open questions. A number of success stories are interwoven to exemplify good practices.

- **SECTION 5:** Presents a general recommendations for aspects which SOCIENTIZE Consortium and consulted stakeholders see in need of change i.e. in need of a policy action. Grouped under different policy levels, these possible measures include strategic and operational improvements forming the starting point for further discussion and refinement.

- **SECTION 6:** Explains the plan and roadmap for the next steps in the consultation process. It will include further online open consultations and public events, like endorsement and debate workshops based on this Green Paper. The final goal is to create a White Paper on Citizen Science in Europe by September 2014.

Finally, **ANNEX I** presents the list of contributors and **ANNEX II** references and literature.



1 Purpose and scope of the Green Paper

This Green Paper aims to foster the interaction between the Citizen Science stakeholders and the EU policy officers, reinforcing the culture of consultation and dialogue in the EU. Interaction between the European Institutions and society takes various forms, primarily via the European Parliament, via institutionalised advisory bodies of the EU and via less formalised direct contacts with interested parties. In this later approach, this document is delivered by the SOCIENTIZE Project to the European Commission's Digital Science Unit as part of the activities carried out under contract number RI-312902.

Wide consultation is not a new phenomenon and the EU Commission has a long tradition consulting interested parties from outside when formulating its policies. Thus, the benefits of being open to outside input are already recognised. SOCIENTIZE is gathering and consolidating contributions of European stakeholders for Citizen Science, and based on them proposing recommendations for European, national and institutional policies. This Green Paper channels a public debate on the key issues to be taken into account about Citizen Science role in the European policies and funding programmes by performing open consultations in a meaningful and systematic way.

This report is the result of the coordination, support and networking activities carried out during the first year of execution of the SOCIENTIZE Project. This document serves as a facilitator of further debate, discussions and feedback, community endorsement, mutual learning and exchange of good practices within the stakeholders. Initially conceived as a draft White Paper, many organisations expressed a desire to supply more detailed comments and country-specific recommendations.

The SOCIENTIZE Consortium, therefore, decided to publish this Green Paper in the form of a consultation document, encouraging all interested parties to submit their experiences on citizen engagement in science and get wider discussion and endorsement during the second year of execution of the SOCIENTIZE Project. As a result, the White Paper on Citizen Science will be created, published and distributed by September 2014.

The SOCIENTIZE Consortium would like to express its gratitude to the large number of people who gave their time freely to contribute information, endorsement, and insight to this Green Paper. Both the quantity and the high quality of the various contributions show the clear interest of outside parties in scientific strategy and policies realted with Citizen Science. There is a list of all contributors in the Annex II.

This work is still in progress without producing any direct impact. Neither the European Commission nor any person acting on behalf of the Commission or the SOCIENTIZE Consortium is responsible for the use which might be made of the following information.

More information
on the SOCIENTIZE Project website
www.socientize.eu

2 Citizen Science in the European policy context

> "In the debate that is ongoing all across Europe, the bottom-line question is: Do we want to improve Europe or give it up? My answer is clear: let's engage! If you don't like Europe as it is: improve it!".
>
> - José Manuel Barroso, President of the European Commission to the European Parliament, 11 September 2013

2.1. Citizen Science alignment within Europe 2020 strategy

Europe has traditionally a clear leadership role at the vanguard of democracy and research advances, and Europe is nowadays facing social, scientific and policy challenges. In the last years, the economic and social context has changed and Europe is now urged to stabilise the economic situation in the short term while also taking measures to ensure growth opportunities of tomorrow.

In 2014, Europe will adopt the new Europe 2020 strategy with three key priorities: smart growth sustainable growth and inclusive growth.

Europe 2020 Flagship initiatives	and Citizen Science alignment
➔ **DIGITAL AGENDA FOR EUROPE**	aims to re-boost Europe's economy and help citizens and businesses to get the most out of digital technologies and information.
➔ **INNOVATION UNION**	recognises European unique set of values and strengths in design, creativity, services and the importance of social innovation.
➔ **YOUTH ON THE MOVE**	highlights that learning isn't limited to schools and plenty of learning happens also outside the classroom.
➔ **AN INDUSTRIAL POLICY FOR THE GLOBALISATION ERA**	supports the shift towards a sustainable growth based on using existing resources more efficiently involving governments, stakeholders and the European public.
➔ **AGENDA FOR NEW SKILLS AND JOBS**	volunteers develop new skills, scientific-technological knowledge, STEM background and beyond.
➔ **EUROPEAN PLATFORM AGAINST POVERTY AND SOCIAL EXCLUSION**	aims to remove barriers in education between other policies. Citizen Science puts a hook on self-learning for risk-of-exclusion citizens.

While this Green Paper focuses on research and innovation, there are important links to other EU programmes, notably to the structural funds for cohesion policy and education programmes.

2.2. Citizen Science in European funding programmes

In the 7th Framework Programme several Citizen Science initiatives have been supported.

EU Funded projects related with Citizen Science	Website
→ **GAP**	http://gap2.eu
→ **WESENSEIT**	http://www.wesenseit.com
→ **R&Dialogue**	http://www.rndialogue.eu
→ **Science Talk**	http://www.e-sciencetalk.org
→ **Voices for Innovation**	http://www.voicesforinnovation.eu
→ **Citclops**	http://www.citclops.eu
→ **CobWeb**	http://cobwebproject.eu
→ **Engage**	http://www.engagedata.eu
→ **Socientize**	http://www.socientize.eu
→ **Citi-Sense**	http://www.citi-sense.eu
→ **EDGI**	http://edgi-project.eu
→ **IDGF**	http://idgf-sp.eu
→ **DRIHM**	http://www.drihm.eu
→ **Gloria**	http://gloria-project.eu/es/
→ **Citizen Cyberlab**	http://citizencyberlab.eu
→ **EU BON**	http://www.eubon.eu
→ **EVERYAWARE**	http://www.everyaware.eu

The proposed Horizon 2020 funding programme for research and innovation is a core part of Europe 2020 strategy: responding to the economic crisis to invest in future jobs and growth; addressing people's concerns about their livelihoods, safety and environment; and strengthening the EU's global position in research, innovation and technology. It sets three priorities: excellent science, industrial leadership and societal challenges; based on motivations including:

- World class science is the foundation of tomorrow's technologies, jobs and wellbeing
- Researchers need access to the best infrastructures
- Concerns of citizens and society/EU policy objectives (climate, environment, energy, transport, etc) cannot be achieved without innovation
- Breakthrough solutions come from multi-disciplinary collaborations, including social sciences and humanities
- Promising solutions need to be tested, demonstrated and scaled up

> "With the aim of deepening the relationship between science and society and reinforcing public confidence in science, Horizon 2020 should favour an informed engagement of citizens and civil society on research and innovation matters by promoting science education, by making scientific knowledge more accessible, by developing responsible research and innovation agendas that meet citizens' and civil society's concerns and expectations and by facilitating their participation in Horizon 2020 activities".
>
> - Official EC for Horizon 2020

These cross-cutting dimensions could be applied to:

- E-infrastructures policy
- Responsible research and innovation
- Digital science (development of research methods)
- European research area
- Policies on specific fields of science/research
- Policies on other fields, based on scientific evidence
- Supporting these through national and European funding

2.3. Citizen science as an element of Digital Science and Responsible Research and Innovation

The Digital Agenda of the EU is managed by the European Commission Directorate General for Communications Networks, Content and Technology (DG CONNECT). In DG CONNECT, a new term "Digital Science" has been adopted in order to promote excellent science in the context of the Digital Agenda, Digital ERA and Horizon 2020.

Digital Science

This new term refers to the ICT-enabled radical transformation of science and innovation within a culture of openness and sharing. Digital Science is more open, global, collaborative, creative and closer to society. One of its basis are the e-infrastructures, services and tools for data and computing intensive research in virtual and collaborative environments. Within the Digital Science in Horizon 2020 Concept Paper, Citizen Science is recognised as trend in the research cycle. Horizon 2020 aims to mainstream Digital Science and Citizen Science will be promoted as part of its objectives.

ICT facilitates a shift of paradigm, with a more open research process sharing good and bad experiences through digital media and collaboration efforts. These new participative and networked relationships promote the transformation of the scientific system, allowing collective intelligence and new collaborative knowledge creation, democratizing research and leading into emergence of new disciplines and connections to study emerging research questions and topics. While doing this, participatory approaches contribute to long-term inclusive education, digital competences, technology skills and wider sense of initiative and ownership.

The Directorate General for Research and Innovation (DG Research and Innovation) is also determined to bridge the gap between the scientific community and society at large. The current "Science in Society" programme is transformed in "Science with and for Society" sustaining a two-way dialogue between researchers and civil society. One of the challenges is the Responsible Research and Innovation (RRI). With the focus on products and services to achieve a social environmental benefit, it includes areas of activities related with public understanding of and engagement in science, formal and informal education, ethics governance or open and free access to publicly funded research results among others. RRI issues include science education, governance for RRI, or integrating society in science and innovation with aspects such as Citizen Science, collaborative scenario building or knowledge sharing support.

Environmental Sciences and Computational Social Science

Besides environmental sciences where experiments produce the necessary data, social systems constitute a major challenge because of the heterogeneous approaches of different science disciplines. Progress can be done by combining computational and experimental approaches and open data is crucial for reproducibility of results. Examples of Science-Society-Policy systems related with Citizen Science:

- Citizen observatories, developing community-based environmental monitoring and information systems using innovative and novel earth observation applications
- Global systems science, combining advanced ICT and citizens dialogues to understand and shape global systems. GSS produces evidence, concepts and doubts needed for effective and responsible policies dealing with global systems.

3

SOCIENTIZE approach to developing a common roadmap for Citizen Science in Europe

Citizen Science has gained wider institutional, political and public attention only rather recently. However, the concept of civic participation and the involving of citizens in the scientific process has a long tradition. In order to capture the current state of affairs and diagnose the most urgent issues a mixed-method approach has been chosen.

The following image gives a broad overview of creation process:

As the image shows the methodology followed the SOCIENTIZE consortium is a combination of different phases:

1. **Exploration, observation and analysis:** identification of current state from literature and in dialogue with consortium members, External Advisory Board (EAB), subcontractors, external experts and other stakeholders. Aim of this phase: identification of common features, crosscutting concerns, shared issues, correlations, patterns.
2. **Mapping and prioritization:** identification of common elements, key factors and challenges, as well as open issues.
3. **Policy recommendations:** Definition of a first set of possible policy recommendations at strategic and operational level based on the previous step
4. **Consultation, feedback, review and endorsement:** first round of consultation with specific stakeholders and revision of open issues
5. **Publication of Green Paper:** the publication of the Green paper initiates the next step of wider consultation
6. **Next steps:** wider consultation, endorsement, complete issues, countries specific issues, white paper

Applied methods and main sources of information

As a first step a traditional approach of state-of-the-art analysis in the form of desktop research was performed in order to synthesize the current knowledge based on Citizen Science. A complete version of this document is available on the SOCIENTIZE website: http://www.socientize.eu

The elaboration of this document depended also heavily on the contribution of different stakeholders and key informants on the topic. Collecting input from the experts has been organised in different steps. Semi-structured interviews were conducted remotely with a first set of key experts.

In parallel, an open consultation process has been launched online. The call for contributions is still open and is accessible for any interested citizen. With this completely open approach, we intend to collect experiences and suggestions from the diverse stakeholders involved in Citizen Science, like volunteers, researchers, infrastructure providers, scientific organizations, communicators, innovators, journalists, educational experts and artists.

In a second step, after having analysed and summarized the main outcomes from the interviews, the state-of-the-art analysis and the open consultation contributions, a first interactive session has been organised with an extended group of experts. Experts met during a 2 h online workshop to reflect on the identified open issues.

Additional input for the current state of affairs has come from a continuous monitoring of Citizen Science projects, own participation and execution of Citizen Science projects, the screening of a wide range of position papers on the future of EU research and innovation and additional informal discussions with interested parties.

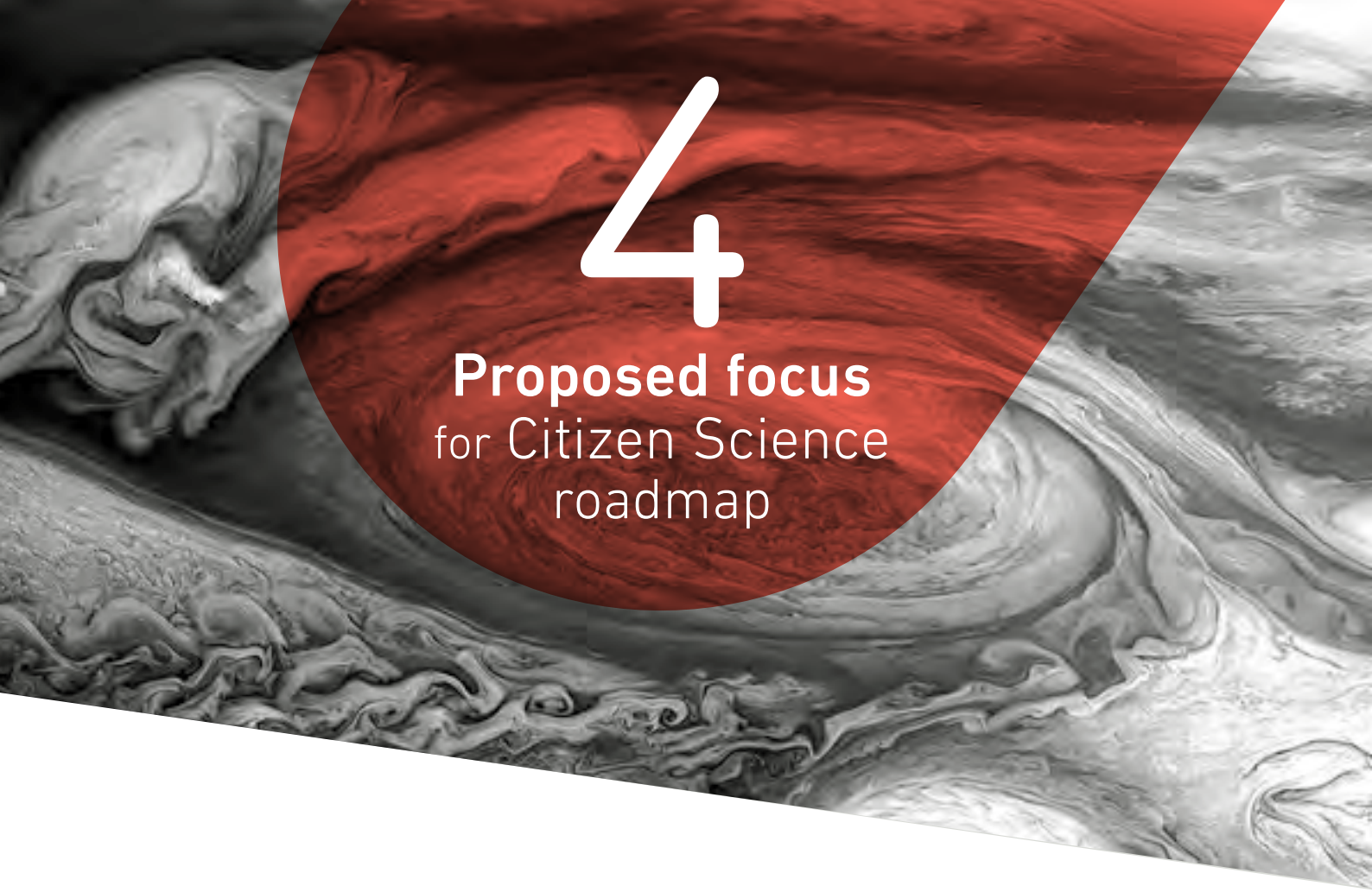
Involved Stakeholders

In order to cover the broad spectrum of Citizen Science and allow for a diversity of opinions and approaches, the group of targeted stakeholders during the process so far has been defined very broadly. It includes especially the following groups:

Stakeholders groups	Profiles
➔ **Science and technology**	Academia, Research Institutions, Public Organizations, Digital Communities, Museums, Infrastructure providers
➔ **Society**	Civil Society Organisations, Local Associations, NGOs, Scholar networks, Media, Communicators, Companies, Living Labs
➔ **Policy makers**	European policy actors, National Funders, Research Agencies

Topics covered

- Cultural change
- Engagement of citizens and scientists
- Openness
- Curricula
- Motivational aspects
- Organisational and structural challenges
- Limitations
- Definition and scope
- Tools
- Standardization
- Collective intelligence
- Business responsibility
- Educational responsibility
- Responsible research and innovation
- Training
- Quality assurance
- Methodologies
- Sustainability
- Governance
- Funding
- Evaluation and impact measurement



4 Proposed focus for Citizen Science roadmap

SOCIENTIZE has detected five major themes of discussions and defined the following focus points around them. In this section we introduce the findings and open issues for each issue.

Leading questions **-** Focus points

1. What is Citizen Science and where it works?
Definition and scope of Citizen Science which support different engagement models, understanding the potential, suitability, risks and linked policies implications

2. How to support Citizen Science takeup?
Deployment, facilitation and sustainability for Citizen Science projects and coordinated activities at local, national and European scale

3. What are the drivers and barriers for Citizen Science?
Awareness and motivation for active involvement of researchers and volunteers, developing understanding of the related challenges

4. How to use Citizen Science successfully?
Drivers and barriers for success, including technologies and cultural shift for sharing among stakeholders amplifying collective intelligence

5. How to measure and appreciate the value of Citizen Science?
Impact measurement and evaluation of the different outcomes based on trusted indicators and new public debates upon efficiency and excellence in science

4.1. Definition and scope of Citizen Science

The term Citizen Science has been used to define a series of activities that link the general public with scientific research. Volunteers and non-professionals contribute collectively in a diverse range of scientific projects to answer real-world questions. Both citizens' contributions and researchers' attitudes encompass a wide set of activities at multiple scales. We find massive occasional interactions at global scale virtually but also regular proactive involvement in local environments identifying new research questions.

Different definitions can be found for Citizen Science, where some take up more traditional aspects, understanding Citizen Science as an approach, which involves volunteers from the general public in scientific investigations during data collection and analysis. Others define it more broadly, as the public participating in scientific research, which includes also scientific activities like the asking of questions, formulation of hypotheses, interpretation of results. Current discussions around the definition of citizen science not only focus on the scope of activities but also what to understand under "volunteers" and how to composite citizen science teams. What we cannot find is one generally accepted definition of citizen science yet.

Cross-cutting aspects of Citizen Science

- Problem definition
- Interdisciplinarity
- Social value
- Scientific impact
- Awareness
- Reluctance
- Motivation for engagement
- Science-society-policy debate
- Digital resources

- Methodology
- Modeling
- Thoroughness
- Quality assurance
- Results sharing
- Reproducibility
- Privacy and IPR
- Evaluation
- Recognition

- Education and training
- Inclusion
- Accessibility
- Feedback
- Interaction and information
- Unpredictable group dynamics
- Design
- Emotional aspects

Open questions

- Should there be a specific definition of Citizen Science officially adopted by the EU? If yes, how broad should it be? Should it support all levels of Citizen Science?
- What kind of balance should be reached between the support for research-driven systematic projects and citizen-driven projects within funding programmes?
- Are there common values among the European Citizen Science projects?

Scope

Many classifications provide categories for different degrees of participations, approaches and goals, where the level of engagement vary widely from person to person and may also change over time. However, the majority of projects adopt similar methodologies, and consider the data gathering and interpretation as the most important aspect, allowing reality-mining used to verify or improve their models more efficiently. There is a demand for more involvement of the volunteers and the establishment of partnerships on equal terms between scientists and citizens, addressing relevant issues of today's society. Digital sharing, online projects and social networks offer new ways to gain acceptance among scientific community and society.

Citizen Science actors must be aware of its potential and risks when determining the engagement level and suitability of this participatory approach for any given scientific problem. When designing a new Citizen Science project or participatory experiment potential risks must be addressed as well as the challenges in marketing and funding mechanisms.

Different categories

- Collaborative science
- Crowd-crafting
- Participatory experiments
- Collective intelligence
- Volunteer thinking
- Volunteer sensing
- Volunteer computing
- Human sensing

Different levels

- Local
- Regional
- National
- European
- Global
- Virtual

Open questions

- Does Citizen Science make a clear impact on the life of citizens?
- What is the role of Citizen Science enhancing excellent science?
- How can it contribute in policy decisions?
- How may the level of volunteer involvement change over time and what does this mean for Citizen Science projects and programmes?
- How to promote private partnerships / industry innovations?
- How to include non scientific disciplines approaches (politics, arts, amateurs...)?
- How could Citizen Science decrease the perceived distances between policymakers and volunteers?
- What are the possible risks, security issues and constraints of Citizen Science?

4.2. Deployment, facilitation and sustainability models

Deployment

Citizen Science has a long history and tradition, but experiences considerable expansion in the last years due to changing science paradigms and the increased usage of innovative technologies, effectively utilizing crowdsourcing for data collection over large geographic regions and bridging volunteers' and researchers' world. To facilitate this growing movement Europe requires both top-down and bottom-up approaches allowing local groups and international networks to deploy and support new initiatives.

In order to underpin European structural problem drivers, policy programmes must ensure sufficient contribution for research and innovation to tackle societal challenges, promoting technological leadership and innovation capability. There is a need to strengthen the science base and critical sense. Education at universities for scientists and students in advanced statistical techniques and computational models, providing students with insights on how to collect, validate and handle huge Citizen Science data sets and how to set up and conduct Citizen Science projects, was identified as another facilitation aspect.

Open questions

- How to convince European and national funding mechanisms to support new Citizen Science projects? How to coordinate them in this issue?
- Should the EC launch specific calls for Citizen Science support?
- How to efficiently support both local and European initiatives?

Facilitation

Despite the general notion of low-cost research, Citizen Science projects require a wide set of profiles in the organizations. Professionalization may increase the productivity but individuals may provide excellent ideas. Networked initiatives need dedicated teams for Citizen Science dissemination, organization of events but also to provide technical support even when adapting scientific models or managing data, and even understanding the volunteer dynamics.

Open questions

- What is the role of cluster initiatives and Citizen Science associations? How to balance the visibility and funding to the end-users?
- What are the most important services these organisations should provide (e.g. practical support and guidance for setting up Citizen Science projects, etc
- On which level do we need these initiatives (European, national, regional)? How could they best cooperate?
- How to share services (e.g. log accounts, workflows, collaborative tools, communication...) among different Citizen Science initiatives?

Sustainability

The long-time sustainability and funding of Citizen Science projects is a challenge for all types of Citizen Science projects. Issues of prioritization and sustainability raise the question of how government funding and partnerships might help sustain public interest in doing science for society.

Most of the Citizen Science projects stand on public funding. Crowdfunding Citizen Science projects is currently considered as an alternative funding strategy. There is however a fear associated with this approach in terms of who is deciding on what research should be funded. Such an open approach might intervene too much in the scientific process. The challenge here is to find the balance between openness and involvement on the one hand and keeping the original idea of the specific research project on the other hand. Selling advertising space on Citizen Science websites is considered another funding model, but there is strong worry that this would devaluate the project.

> "An economic analysis of the relative costs of different forms of computing is needed. With volunteer computing you can do more computing for less money".
>
> - David Anderson (Space Science Laboratory, University of California, Berkeley; project director of BOINC)

There are also economic factors in favour of externalizing resources but it still requires a deeper economic analysis of relative costs of different forms of Citizen Science compared with other e-infrastructures.

Open questions

- Is there a need for new sustainability and funding models? Are there good practices to follow within the EU?
- How to scale up successful local experiments?
- How to fund in the long term large infrastructures for huge, dispersed and persistent data sets?

4.3. Awareness and motivation for active involvement

Engaging new citizens

Attracting and retaining people who would be willing to contribute their skills, time, and effort for a scientific cause is an important pillar of Citizen Science work. Media coverage, approaching existing institutions, using social networking features, but also collecting first positive hands-on-experiences with science are potential drivers.

The initial phase of involvement, when volunteers need to understand the projects' objectives and opportunities for contribution, has been identified as the most critical one. The majority of volunteers only perform activities one day and do not return to execute more tasks, so the regular minority contribute for the larger proportion of tasks carried out in the project. Once volunteers are involved the next challenge is keeping them engaged. This requires finding out what motivates them in the long run, but also continuous personal information flows between the involved stakeholders and well adapted and interesting tasks are important.

The involvement of citizens in scientific projects tends to have an educational value, implicit or explicit. While in the majority of projects the informal learning aspect of adult citizens is addressed, schools are more and more considered an important target for the introduction and promotion of Citizen Science. Teachers play a relevant role easing the deployment of experiments and transmitting the socio-scientific values of their contributions to the young audience.

Open questions

- How to increase awareness and linkages among all the actors considering their roles and motivations?
- How to make the most of the differences on conditions in Europe (investments, social culture, technologies adoption, legislation...)? How to avoid that those citizens who don't have access to technology are excluded
- How could we best support Citizen Science in schools and what role are teachers playing? Should we address younger audience in primary schools?
- How should Citizen Science be addressed in the academic curriculum at different levels (primary and secondary education, undergraduate and graduate level, etc.)?

> I see great potential in Citizen Science projects to attract young people into science if they are approached at the right time. The educational goal of Citizen Science is most exciting".

- Ben Segal (honorary staff member at CERN, member of Citizen Cyberscience Centre)

Motivation for active involvement

Motivational drivers and barriers for both scientists and volunteers are diverse and depend on the project type but also on the context in which volunteer engagement is taking place. While in some contexts providing valuable contributions to science or to the local community might be the most important motivational driver for citizens' involvement, in other contexts it might be monetary incentives, as only financial aid would render the participation possible for some participants. Intrinsic motivators, like the interest in the scientific topic or the satisfaction from contributing to science, have been identified as being amongst the most important drivers for volunteers' participation.

But when a preferably large number of citizens should be involved over longer time spans in Citizen Science projects (that might be less intrinsically motivating), external motivators, like community recognition, competitive elements, or incentives come into play. Volunteers' motivations are said to be temporal, dynamic and changing even when the ultimate goal remains the same. Physical spaces devoted to Citizen Science and face to face meetings are understood as effective tools to improve community aspects, easing social interaction, media coverage and emergent group dynamics.

Open questions

- What are the motivational drivers and barriers related to different types of Citizen Science projects and how do they change over time?
- Do we need any expert help (publicists, psychologists, etc.) to find the "real" motivations of people?

Awareness and motivation among researchers

Motivational issue do not only consider volunteers, they are also relevant for the involvement of scientists. Involving non-scientists, new scientific areas, and engage long-tail researchers in Citizen Science will promote new research advances. In this multi- and inter-disciplinary context, we find barriers like vocabulary, practices, meanings, but also competencies, mutual recognition, and prestige. Establishing trustful, balanced collaboration between these groups is not always an easy matter and must be encouraged also through non-academic means.

It is said that in many institutions there is still a lot of resistant scepticism amongst researchers. Scientists need to understand that Citizen Science is committed to authentic and enhanced research which can bring viewpoints and perspectives not otherwise available to science.

It takes an additional effort to redefine their models and assumptions, and interacting with volunteers is time consuming, but it opens new sources of data, decreases costs in infrastructure deployment and operational and opens the door for new funding opportunities.

Open questions

- How to disseminate and motivate the involvement of citizens in research amongst researchers?
- How to engage more volunteers in the scientific problem definition?

Scientific values and opportunities

- Large sets of existing and connected resources, with enormous granularity in space and time
- Large local and reality knowledge provided by amateur also providing valuable feedback and collective ideas
- Large experimental datasets and digital footprints
- Existing mature e-infrastructures and open technologies allow efficient management of data and virtual environments for creating multidisciplinary and global research groups
- Potential in scientific dissemination about research and policy issues
- New ways of greater recognition and impact

4.4. Drivers and barriers for Citizen Science

Drivers

Citizen Science in Europe forms a complex environment where many agents tend to cross boundaries fostering growth at European level. A cultural change is happening at global scale through inspirational success stories of collaborative open-minded approaches breaking the walls of disciplines with transdisciplinary strategies. The combination of the distributed knowledge of the citizens with the systemic methodologies of the researchers represents a ground-breaking driving force when addressing global challenges.

The use of e-Infrastructures is a relevant enabler for Citizen Science providing storage and accessibility for the data sets as well as the computing power to manage the data. Citizen-based resources like networks of desktop computers, mobile phones and other devices can be considered as part of the available resources for the e-scientists, complementing services with a different approach. Some efforts have been done addressing common services but further progress is needed.
The unprecedented scale in number and performance of citizen's devices and the ubiquitous coverage of high-speed connectivity allow Citizen Science to gain notable relevance for research in Europe.

Openness in the context of Citizen Science relates to the software used as well as to the data gathered. Current projects are based on proprietary software as well as on open source software with a clear trend towards openness. Openness improve speed, efficiency and efficacy of science policy measures, allowing researchers and general public faster access to the information. New ways of interaction through social media, direct involvement or artistic visualizations also improve the interaction between science-society-policy agents.

There are also some initiatives highlighting the value of artistic approaches for participatory science, bringing wider public into the process and encouraging creativity. The emotional side of communication acquires a new dimension while new formats of visualization of scientific data are consolidated. The number of shared spaces of conceptualization, observation and interaction between science-technology-arts is growing as complement of more established spaces like science museums. Participatory experiments are gaining acceptance within all the interested parties as the research impact of scientific advances and awareness among researchers grows in the last few years. Despite Citizen Science is still in its infancy and this makes some promises highly risked, ICT will continue to foster and accelerate huge advances.

Open questions

- Is there a need for shared services and interoperability between Citizen Science experiments and e-infrastructures?
- Should Citizen Science only useopen source software?
- Are Citizen Science experiments faultless and reproducible?
- Does openness increase confidence in and validity of Citizen Science findings?
- How to promote the values of Citizen Science compared to established scientific approach?

Barriers

There is a recurrent debate about data reliability. Despite there are many successful experiences using different techniques to ensure quality and accuracy of data, it is a common issue for some scientific areas.

Access and interoperability of the Citizen Science data sets should be improved in many cases. Large data sets based on Citizen Science data have been created by scientists for their own needs and are often difficult to be used by other groups, like citizens or researchers. In addition, there is a claim that public authorities and companies provide open access to their data as well in order to be used by citizen scientists for their research and also increase interoperability between these data sets. When opening the data sets, the important question of ownership and IPR issues arises. A frequent issue for scientists who work in Citizen Science projects is that they do not want to share and provide access to the collected data. When companies as sponsors are involved it might even complicate this issue.

Only few projects have a clear policy about the ownership of the results, and especially volunteers are hardly informed about the intellectual property rights of projects they have been involved in. Hardly any regulations are foreseen for the use of the data by third parties. Experts require a political decision regarding the access to scientific data.

Regarding interoperability of data, there have been first efforts in the United States to synchronise data amongst data sets, but these efforts are still in the very early stages. That's why one of the biggest goals is that people working in this field define data standards that all Citizen Science projects can use.

Another claim by some experts in the community is that Citizen Science platforms and software should be free to use and preferably open source, as this would best fit the initial idea of voluntariness, openness and collaboration.

Open questions

- Should there be open access and interoperability between Citizen Science datasets and/or public data?
- Is there a need for standards in terms of used technology and interoperability?
- Is there a need to improve privacy regulations and IPR issues with regards to data usage and ownership
- Is there any effective anonymization technique for privacy data sharing?

4.5. Impact measurement and evaluation

Measuring impact and value of Citizen Science

Citizen Science generates a diverse set of outcomes for science, individual participants and socio-ecological systems, which determine the success of a project. In the core of all Citizen Science projects is the scientific progress, next to advances in individual participants and local communities/societies as well as educational benefits. The degree to which the divers outcomes are realized depends on the type of the project and its objectives.

As a complex collective activity, in Citizen Science the total is more than the sum of the parts and overall performance depends on researchers excellence, technological equipment and their networking capabilities, notably commitment and interactions with society.

The involvement of citizens helps to collect and analyse data that could not be treated any other way easily and makes use of computing power, time, cognition and human perception from volunteers to support the analysis of data. It allows gathering large volume of field data on large geographic scales or long time spans. Citizen science provides new opportunities to widen the scope of traditional projects, combining natural systems together with social data. It has the potential to better investigate and understand how society and culture influences environmental issues and how these systems are dynamically interlinked with each other.

The challenge is to disconnect from traditional ways of conducting science and thinking about new opportunities for innovation and insights that lies at the interface of science and society and in the links between disciplines.

Different motivations

- Scientific
- Economic
- Social
- Environmental
- Educational
- Inspirational
- Volunteer computing
- Human sensing

Different outcomes

- Publications
- Findings
- Critical mass
- Low-cost
- Crowdsourcing
- Innovation
- Actions
- Legislations
- Relationships
- Conservation

- Sustainability
- Consciousness
- Skills
- Knowledge
- Empowerment
- Debate
- Emotions
- Identity
- Ownership

Projects that directly involve members of the public in scientific research seem particularly suitable for increasing participants' awareness, content and scientific knowledge as well as some changes in attitudes towards science and in behaviour related to the topic under investigation. Studies which investigated the knowledge increase amongst volunteers stress the importance of collaborative and co-created projects as well as projects which cover a broader spectrum of activities for volunteers to make learning amongst citizens more robust.

> We should promote the next phase of Citizen Science as "Crowdcrafting" where citizens make projects with the help of scientists, not only for the benefits of professionals but for the benefits of society, a rather citizen-driven research".
>
> - Francois Grey (coordinator of the Citizen Cyberscience Centre)

In action-oriented and conservation projects scientific knowledge supports local initiatives to provide evidence for interventions influencing in policy decision-making. An increasing number of literature points out to the benefits of combining scattered local and practical knowledge from communities with the scientific work. To better understand the contribution of Citizen Science to science and society, advanced measurement tools and assessment scales are required in order to evaluate and compare the outcomes and effectiveness across multiple Citizen Science projects.

Open questions

- Would a standardised impact measurement across multiple European Citizen Science projects foster the larger expansion and acceptance of this approach?
- Who should be the actors to create these measurement tools and assessment scales?
- How to measure balanced scientific, social and educational impact?
- How to ensure efficiency and added value to the public contributions?
- How can we extract and recognise additional values of Citizen Science, such as ready access to information, transparent and responsive procedures or flexible working arrangements?

Including Citizen Science into scientific value system

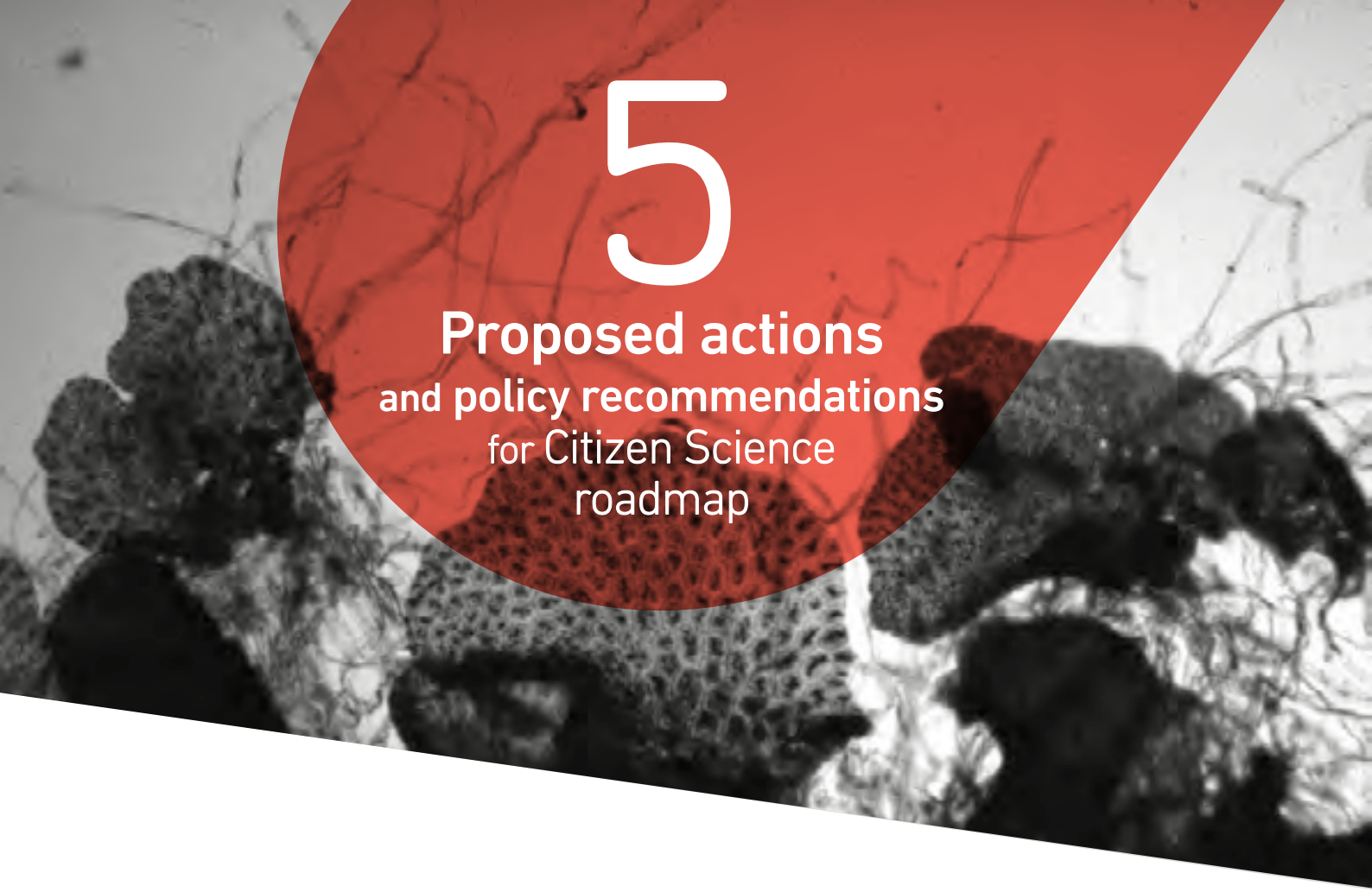
Trans-disciplinary approaches represent an opportunity for cutting-edge research but the involvement of the public in scientific research still faces some resistance and scepticism in the scientific world. In the case of Citizen Science the wide range of heterogeneous stakeholders with different motivations and objectives tends to challenge the fundamental mechanisms of scientific evaluation systems.

Despite the fact that participatory experiments increase the visibility of research and researchers, there are few motivations for them to perform activities without explicit recognition in the scientific value system. It is broadly understood within the scientific community that dissemination or inspirational approaches have less scientific value than traditional research outcomes like peer-reviewed publications. But collaborative and co-crated approaches often have other, more practical goals, from the collaboration with citizens. They are rather expressed in actions and practical results than in emphasis on data gathering for mainly scientific interpretations and outcomes.

To effectively foster the wide adoption of citizen science in the research world we have to question the existing scientific value system and open it up to integrate more practical benefits of research, which are expressed in a concrete set of measures and indicators promoted at European level.

Open questions

- How can the awareness of potential scientific value be improved and compared to established scientific approach?
- How should Citizen Science be addressed in the scientific value systems?



5

Proposed actions and policy recommendations for Citizen Science roadmap

The set of open questions presented in the previous section group the issues discussed with the stakeholders during the first year of the SOCIENTIZE project. The recommendations presented below are based on contributions gathered by the Consortium from the contributors. They are grouped in three levels: policy, science and technology, and society.

This set of suggestions will be presented, discussed, completed and improved through the public consultation presented in the Chapter 6 of this document so related parties are encouraged to suggest improvements and more aspects that need specific policy actions.

Policy level.

European and national policy actors

- Define the scope of Citizen Science and its participatory model, adopting the implications of the definition on the support measures e.g. reflecting it in the funding schemes, setting a list of requirements for the Citizen Science projects, launching specific calls, and favouring projects that include Citizen Science aspects.

- Identify, catalogue and align funding programmes related with Citizen Science, developing a strategic agenda and promoting synergies between EU and national funding mechanisms, optimising individual strengths of every region.

- Promote the development and implementation of Citizen Science agenda in Europe, with strategic roadmap and actions, created jointly with all the stakeholders.

- Promote structured partnerships and international networks of cooperation of Citizen Science institutions from different regions, including excellent research institutions and low performing who benefit from the insight of experienced initiatives, and promoting the upscaling of regional successful initiatives in order to validate models.

- Enhance public debate and decision-making processes on science challenges and policies, giving more publicity to the funded projects and increasing the participation of the society in the meetings organized about funding programmes.

- Launch a tender to create a standard set of impact measurement toolbox that should facilitate the evaluation of any Citizen Science project. Ensure that all Citizen Science projects financially supported perform impact measurement.

Science and technology level.

Research funders and Research institutions

- Raise awareness amongst researchers to perform Citizen Science with knowledge exchange and public interaction making explicit the importance of involving different stakeholders e.g. civil society organizations; even through non-academic means e.g. artistic performance, storytelling or film making. Consider an operational scheme to include all the interested parties in funded projects.

- Promote both supporting initiatives, offering services to the community, and researchers groups implementing success stories. Ensure that best practices are shared among public funded projects.

- Reform researcher evaluation and reputation systems, and definition of incentives for interaction with citizens, such as recognition in appraisal and tenures.

- Promote the design and definition of sustainability models for Citizen Science projects with long-term commitment for infrastructures and data repositories.

- Promote the creation of appropriate tools as well as standards for interoperability, metadata, citations, anonymization and accessibility.

- Adopt Open Source and Open Access policy, developing a set of indicators to measure open access. Encourage resources sharing including access to journals, methods, data, tools, and equipment akin to open science.

Society level.

Public institutions, organizations and citizen associations

- Promote cultural change and new scientific culture by increasing the benefits for researchers, public institutions and industry of opening, sharing and co-creation.
- Support inspirational projects which can lead to breakthrough research and innovation based on the collective intelligence.
- Promote public spaces and events in Europe specifically promoting Citizen Science initiatives and teaming with science festivals and science museums, open laboratories and citizens communities.
- Promote both informal and formal recognition as well as incentives for citizens contributing in Citizen Science e.g. diplomas, discount vouchers in business, etc.
- Define governance structures regarding data ownership and usage.
- Promote democratic governance of science via public engagement and debate between policy makers, researchers, innovators and the general public in a structured channel for feedback and open criticism. Consider an organisational structure to facilitate general public evaluation of science policies and public funded projects.

6 Next steps and roadmap

The creation of the White Paper on Citizen Science will be based on a second round of broad consultation, where the wide range of stakeholders will be invited to participate and debate on the basis of the first relevant topics, open questions and policy recommendations of this Green Paper, which will be spread in digital or paper format amongst all the interested parties.

A continuous dialogue with partners, subcontractors, citizens, scientists, infrastructure providers and experts will lead to the wider endorsement, collection of further inputs, the refinement of the first strategies of the Green Paper as well as a prioritization of topics. It will help to compile success criteria for Citizen Science in Europe, best practices, as well as potential risks and requisites for the broader implementation of this approach.

This consultation process will be organised from 7th of January to 7th of April 2014 in the on- and offline world.

Open consultation process

The Green Paper will be published and put under discussion by the stakeholders using a collective consultation tool, supported by social media. This tool will support the open debate, facilitate the collection of the stakeholder's knowledge, provide an overview of the topics under discussion, identify further experiences from the field, open questions and policy recommendations. Follow-up roadmap and implementation of the outcome of the White Paper will be also taken into account.

Endorsement and debate workshop

After the deadline for submitting responses, the SOCIENTIZE project will organise a workshop to present and discuss the outcome of the consultation. The Green Paper will be presented in workshops, science events and conferences amongst the stakeholders.

The feedback from the open consultation process and the workshops will be collected analysed, synthesised and feed the White Paper on Citizen Science.

Invitation to the consultation process

Consultation will be disseminated between main stakeholders and the general public. All participants, who have already contributed to the Green Paper, will be actively involved in the online and offline consultation activities. In addition the dissemination channels of the SOCIENTIZE consortium (company and personal networks, social media, newsletters and websites etc.) will be used to broadly distribute the invitation to participate in the consultation process throughout this three months period. Stakeholders for the consultation are scientists, science communicators, Citizen Science experts, Citizen Science volunteers, artist, policy makers, organisations, and infrastructure providers. European and national policy officers are invited to promote the debate with their stakeholders.

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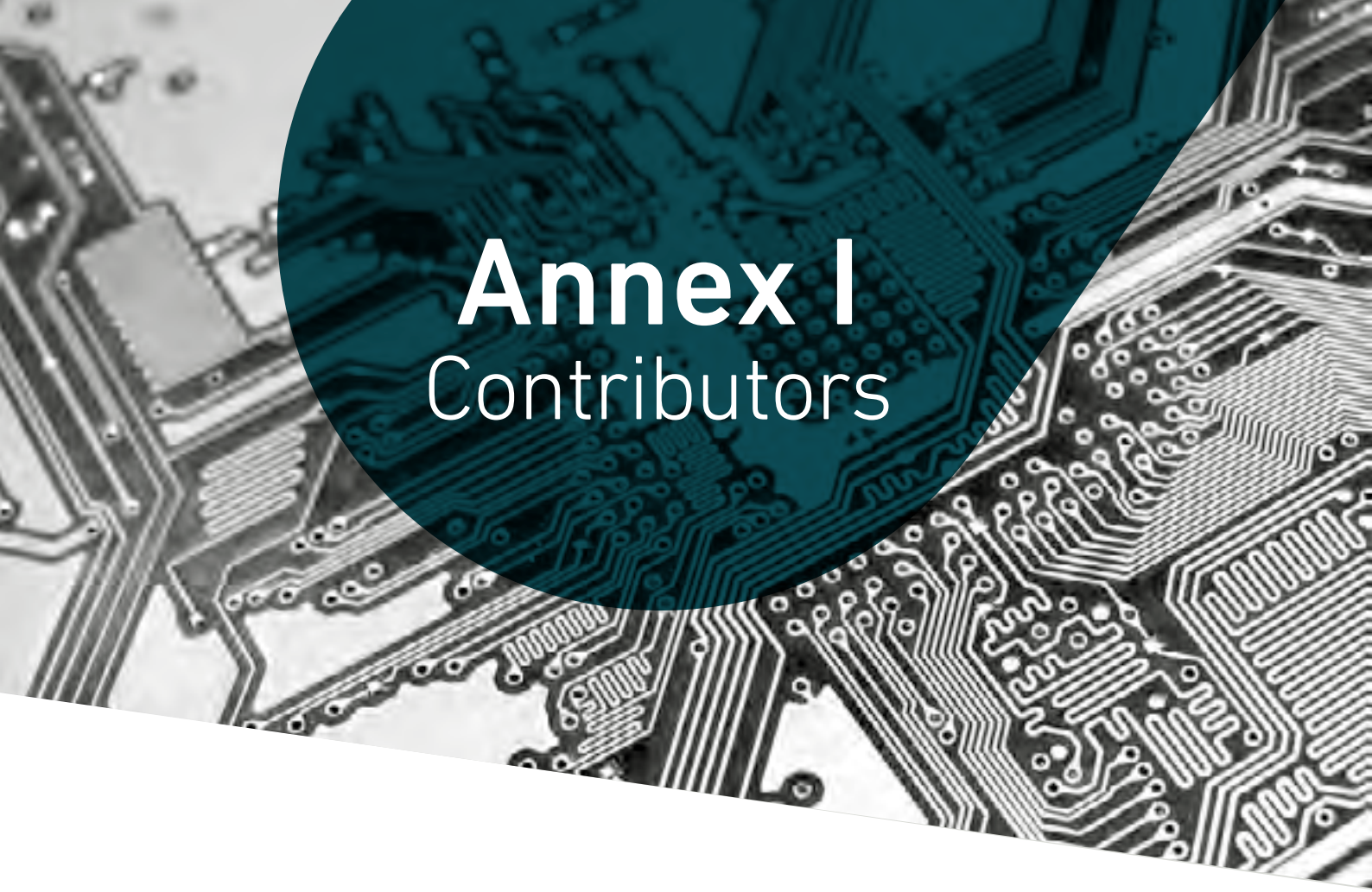

Annex I
Contributors

We want to thank all our formal contributors. In addition, we want to express its gratitude to all our informal contacts in our organisations and networks for all their input during fruitful discussions and experience sharing.

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1.1. Experts interviews

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Drew Hemment	FutureEverything	Founder and CEO. SOCIENTIZE External Advisory Board Member.
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Jennifer Shirk	The Cornell Lab of Ornithology	Project Leader CitizenScience.org

1.2. Open Call for contributions

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1.3. Registered participants for the virtual workshop

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Ronald Smallenburg	Science in Action	Business director
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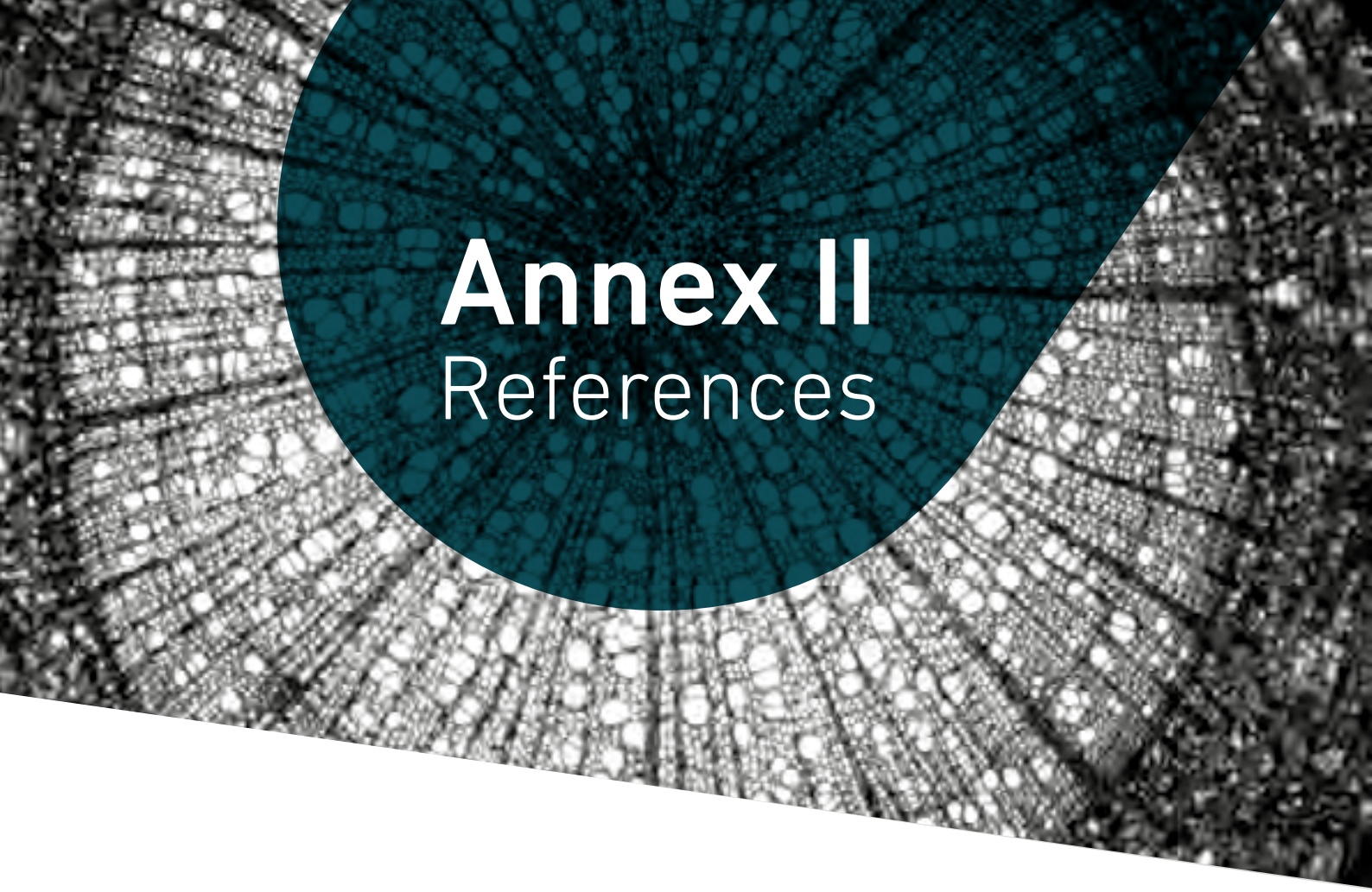

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"In the debate that is ongoing all across Europe, the bottom-line question is: Do we want to improve Europe or give it up? My answer is clear: let's engage! If you don't like Europe as it is: improve it!"

- José Manuel Barroso, President of the European Commission to the European Parliament, 11 September 2013