



JRC CONFERENCE AND WORKSHOP REPORTS

# Citizens Science and Environmental Monitoring

*Benefits and Challenges*

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## **Abstract**

On the 21<sup>st</sup> and 22<sup>nd</sup> of November 2018, a two days' workshop was co-organized, by the JRC and the Working Group 3 "Improving Society-Science Policy Interface" of the COST Action 15212 "Citizen Science to promote creativity, scientific literacy, and innovation throughout Europe". The workshop took place at the JRCs premises in Ispra, Italy. This event represented an excellent and timely opportunity to host stakeholders groups from policy bodies, scientific communities and representatives from a number of Citizens' Science associations, and to discuss and elaborate on the opportunities and challenges brought forward by the increasing need and use of Citizen Science (CS) approaches in support to policy making.

The ultimate goal of the workshop was to provide recommendations, stemming from all stakeholders, namely from the scientific, policy and citizens perspectives, on the way forward for improving developments, promoting and accelerating the use of Citizens Science for (environment-related) policy making throughout Europe.

The workshop acted also as a springboard for presenting the outline and intermediate findings of a recent study commissioned by DG Environment ("Study on an inventory of citizen science activities for environmental policies") and a very first draft of the guidelines for CS in support to environmental reporting, which is currently under development as part of the Actions to Streamline Environmental Reporting (COM(2017) 312). These very first draft documents provided useful material for discussion, especially in view of developing the above mentioned guidelines.

The approximately 45 participants from a number of COST Countries, European Commission (EC) Services, and international Organizations active in the environmental and CS domains (such as the European Citizen Science Association - ECSA), confirmed that growing interest in an increased knowledge exchange amongst diverse stakeholders and CS initiatives, and the need for the development for a robust, while flexible, reference architecture for the development of guidelines for environmental monitoring and reporting, calling upon the benefits offered by CS approaches.

The outputs from these two days joint effort and collaborative work are a collection of presentations about activities and best practices in the environmental domain, and precious expert feedback and recommendations on a number of issues deemed to be of priority for discussion both, in terms potentialities and challenges encountered by CS approaches applied to policy making at EU and at Member State level.

As a further concrete outcome, the event offered a number of valuable expert contributions from the three main stakeholder representatives, on the very first draft guidelines on CS for environmental monitoring, and the related draft roadmap.

# 1 Introduction

Citizen Science (CS) is getting higher both, in EU Member States and in the EU policy making agendas, as policy makers increasingly recognize the potential of Citizen Science as a precious and novel source of information in support to EU environment-related policies.

In this context, the JRC pro-actively contributes to scientific and technical debates about Citizen Science in the environmental domain through the *Environmental Knowledge Community*, a collaboration between different services of the European Commission (DGs Environment, Climate, Research and Innovation, Agriculture, Eurostat, and JRC) and the European Environment Agency (EEA) to exploit new ways of creating and exchanging knowledge related to environmental policy-making, through initiatives supporting research and policy in the environmental domain, including the promotion of Citizens Science for environment-related policy making.

In particular, the Action 8 of the EC Action Plan for Environmental Reporting ([COM\(2017\) 312](#)), promotes the wider use of citizen science to complement environmental reporting, thus providing the different stakeholders with an unique opportunity to contribute to the drafting of guidelines on how Citizen Science for environmental monitoring and reporting can be applied and mainstreamed in policy making at EU level. These guidelines should be provided by the EC in the end of 2019.

The [COST Action 15212 "Citizen Science to promote creativity, scientific literacy, and innovation throughout Europe"](#) has the main aim to bundle capacities across Europe to investigate and extend the impact of the scientific, educational, policy, and civic outcomes of citizen science with the stakeholders from all sectors concerned (e.g., policy makers, social innovators, citizens, cultural organizations, researchers, charities and non-governmental organizations), in order to gauge the potential of citizen science as enabler of social innovation and socio-ecological transition. Currently, 36 member countries signed the COST Actions Memorandum of Understanding (MoU), and members of 38 countries registered at the webpage and feel part of this Citizen Science Action, contribute to workshops, host young scientists, or develop scientific papers.

The [COST Action's Working Group 3 "Improve society-science-policy interface"](#) focuses on the outcomes of Citizen Science projects for policy makers at local, national, and European level concerned with policies impacting the environment and society. The objective of this WG is to make government officials and decision makers aware of Citizen Science by providing evidence and guidance material, so that they can use it as part of policy formation, implementation and evaluation.

As a co-organised effort, this workshop provided an excellent opportunity to match the policy needs of the European Commission with the scientific expert knowledge of the COST Action and of the JRC. The meeting agenda is attached as Annex 2 to this report.

## 2 Summary of the event

The first day of the event dedicated to CS in environmental monitoring, overlapped partially with the one about CS and Invasive Alien Species, which the JRC co-organised with another [COST Action \(17122 “Increasing understanding of alien species through citizen science”\)](#). This set-up allowed a higher number of experts in the same domain to benefit from both events and relevant networking activities. All experts from both workshops participated therefore to the final session of the Invasive Alien Species event, whereby the main preliminary conclusions were presented by the organisers. Furthermore all participated in a field exercise in order to test and provide feedback about the JRC-developed mobile application [“Invasive Alien Species in Europe”](#).

After the closure of the workshop on Invasive Alien Species, the co-organisers welcomed the experts and colleagues, and the workshop on CS in environmental monitoring was then introduced, including its objectives, the organisation planned for the two-days, the presentation of participants and their expectations (tour de table), including the participants groupings, for the group work of the following day, around the core questions to be addressed and their rapporteurs.

The organizers then wrapped up and closed the first day.

The second day was dedicated to the presentation and discussion of the core dimensions, and included the following sections: Scene Setting from the JRC and COST co-organizers and introduction to CS activities in DG Environment and in the EEA; *Citizens Science and Policy Makers* followed by the session on *Citizens Science across geographical scales* - both including short presentations from different CS international bodies, followed by group discussions around the selected core questions, reporting back from the groups, and a plenary discussion.

The co-organizers collected the different key issues emerged, the preliminary conclusions and recommendations, collected the final comments from the participants and discussed and agreed with them the way ahead and the next steps. Then the event was closed by the co-organisers. The meeting agenda is annexed to this report (Annex 1).

Overall, the JRC hosted approximately 45 participants evenly distributed amongst three main expert groups (15 invited by the JRC, 15 invited by the COST Action, and 15 EC and JRC colleagues).

### 2.1 First day

#### 2.1.1 Conclusions from the meeting “Strengthening the link between Invasive Alien Species (IAS) apps data and policy

This session was a hand-shake with another meeting that took place at the JRC in collaboration with the COST Action 17122 (Alien CSI). We organised this joint session due to the relevance of the work on Citizen Science for detecting Invasive Alien Species, to our more generically scoped discussions on Citizen Science and environmental monitoring.

The main point of relevance to CS activities in the environmental domain that needs to be mentioned from the conclusions from the IAS workshops, considers the fundamental role that NGOs have in linking up the main stakeholders, namely from the public authorities the scientific communities and the citizens, and the way they could share responsibility. In fact, it was proposed to distinguish NGOs working at International level from both working at national, regional and local level as their objectives, tasks and responsibilities are by nature different in that:

- NGOs acting at International level might consider:
  - linking up different communities and related platforms,

- validate platforms and their working practices,
- develop, validate and promote relevant guidelines,
- launching awareness campaigns, and
- promote CS amongst the different international stakeholders.
- NGOs acting at National/Regional/Local level could:
  - validate existing guidelines,
  - train users and practitioners,
  - reach-out to the relevant local communities, and
  - provide feedback to the NGOs at international level.

The above recommendations are equally applicable to and desirable for CS practices applied to the environmental domain and CS activities in general.

The follow-up of the IAS meeting included the compilation and analysis of the material from the WS, and its publication on specialized magazines.

### **2.1.2 Introduction to the workshop “Citizen Science and Environmental Monitoring: Benefits and Challenges”**

Katrin Vohland (Chair of the Citizen Science Cost Action CA 15212, Museum für Naturkunde Berlin) and Marina Manzoni (JRC, Unit B.6 – Digital Economy) opened the event by welcoming the experts, thanking them for their contribution, briefly explaining the rationale and of the event, its logistical and organizational main features, and then invited the experts to provide a brief self-presentation, including their expectations from the event.

### **2.1.3 COST Action 15212 and WG3**

Katrin Vohland presented the COST Action and its Working Group 3, passing the following messages:

- COST Actions are a tool to trigger scientific networks throughout Europe.
- COST Actions are governed like an intergovernmental body: each country nominates two MC members as scientific and country representatives with voting rights. The activities themselves are open to everybody.
- Criteria for COST are scientific excellence and inclusiveness with regard to geography, gender, and young scientists.
- This COST Action on CS is focusing on the ambiguity, challenges and specificities of CS for policy making, including issues of responsibility and ownership, Open Science, participation and coproduction, as well as, education and scientific advancement and literacy.
- WG 3 of this COST Action explores the different CS strategies of the different countries, the link between CS and Open Science as well as the link to Environmental Monitoring.
- CS is a broad phenomenon field taking place in different places.
- CS should be mutually beneficial to all the stakeholders.

- CS is not cheap data and, on the contrary, it needs investments.
- New capacity building project starts in early 2019: *EU-Citizen.Science*

#### **2.1.4 Meeting objectives**

The context and scope of the event were explained by Sven Schade (JRC Unit B6 – Digital Economy), including different opportunities and challenges. Main messages included:

- Identify diversity and responsibilities in the context of environmental monitoring and how it can be advanced at different scale.
- Provide a concrete opportunity to impact on a current policy process in the ENV monitoring domain (consultation process with guidelines DG ENV guidelines and roadmap).
- Provide clarity on what it is desired by which actors.
- Collect good practices of cooperation between CS, science, and administration.
- Identify the need and/or opportunity to promote new activities.
- Discuss a set of core questions in working groups.
- Work groups to identify key issues, concrete action and responsibilities.

#### **2.1.5 Expectations from participants in the Workshop: Tour de table**

After welcoming the experts the main expectations were expressed as follows:

- Gain experience/overview/understanding of the main issues and practices of CS in the different countries and domains.
- Share good practices, lessons learned, success stories.
- Provide and get expertise and connection to other experts.
- Getting to know who are the main actors in this domain, and understand better their role.
- Identify challenges and opportunities.
- Identify main issues to be addressed (e.g. data ownership).
- Contributing to the development of DG ENVIRONEMT's guidelines.
- What citizens can really bring to a new model for monitoring?
- Increasing interest from EC in engagement practices and how can CS contribute to other area.
- Identify the possibility to give a boost CS and budget allocated to them for sustainability.
- Engagement of Citizens in science and technologies from the policy perspective exploring new methods for Citizens engagements.
- How to deal with data and create data for policy making?
- How to feed these data into policy making projects and create success stories?
- How is CS data seen across Europe?

Prof. Andrea Giacomelli provided a short presentation on his experience with CS and novel forms of CS participation, and in engaging the main stakeholders, concluding that the bigger difficulties lays in relating with NGOs and public authorities.

## 2.1.6 Wrap-up and fine-tuning of goals for the next day

Katrin Vohland closed the day by highlighting the following:

- Group discussions - template organization and logistics.
- Explanation of core questions.
- Initial allocation of reporters and core questions to groups.

## 2.2 Second day

The agenda of the day was presented, fine-tuned, and agreed with participants (see also [scene-setting presentations](#)).

### 2.2.1 Highlights from relevant EC activities

Sven Schade presented the following:

- Overview of EU actions, initiatives, policy documents.
- Introduction to the [study "A Dedicated inventory on Environmental CS projects in the environmental domain in the EU"](#). How CS projects can be better connected/contribute at different stages of policy processes, to which policy are they connected, providing mapping of issues addressed with reference to Sustainable Development Goals , Intermediate results are available and its publication is planned for next year, and it can be enriched by other projects).
- CS and innovation in Open Science and Society, referring to a compendium of knowledge in this area.
- Next steps: promote re-use of data & methods fostering CS standards/taking the policy related action.

### 2.2.4 Scene setter on Action 8: "**Promote the wider use of citizen science to complement environmental reporting**" within the EC Action Plan to streamline environmental reporting

Elena Montani (DG Environment, Unit A.3) presented the first **draft skeleton of the Guidelines for citizen science in environmental monitoring and reporting and related Roadmap** and opened the discussion with key citizen science actors (citizen science communities, Environmental Protection Agencies, researchers) and receive input for the development of the Guidelines (to be adopted in 2019) and collect their recommendations.

In particular the following issues were highlighted:

- Background and flow of environmental reporting in EU environmental policy.
- A rich set of already on-going initiatives.
- Need to streamline this process in terms of financial and better quality, understanding, comparison, transparency and accountability of information and data, info analysis, interpretation and sharing methodologies, like timing for publication of information and conclusions.
- [Action Plan on Environmental monitoring and reporting](#), including Action 8: Promote the wider use of citizen science to complement environmental reporting how CS can complement monitoring and reporting.

- Study results show that CS is present but not sufficiently used, therefore we need guidelines on how to promote, develop and make the most of its use/practices.
- Roadmap for the guidelines: Objectives/structure/main issues of the Guidelines
- Study intermediate results:
  - main challenges are seen as the uptake by, and links to Public Administrations, ownership, privacy, quality of data recognition of contribution, how to structure the processes
  - opportunities and benefits are identified in improved knowledge base at all levels, timely reliable and fit for purpose, inclusiveness, better quality for money, empowerment creation of alliances, behavioural change
  - facilitating factors are to be found in government support, promote citizens engagement, scientific excellence and sustainable business models
  - NGOs are key to this process joining the dots between the different actors
- Conclusions:
  - CS can underpin policy including monitoring SDGs.
  - We need to bridge the gap, develop standards and interoperability, track the use of CS data needs with reference to resources, maximise their potential.

#### 2.2.4.1 Questions and answers

- Q. Is the "How to the rebuild trust in science" issue being addressed?  
 A. *(This was then discussed in the working groups, see below).*
- Q. Is training and capacity building by NGOs taken into account when talking about cost effectiveness?  
 A. Yes, this is one important element of the considerations. In addition, there are also additional aspects that cannot be monetized and this is why we talk about value for money.
- Q. How to feature CS initiatives that are not aligned with institutional channels/processes?  
 A. Initiatives, such as, the CS the living inventory in COST Countries could provide an example of hosting place for such initiatives in a specific section, probably for policy "design" or "compliance" assurance.

#### 2.2.4.2 Additional Considerations:

- Start-up costs are high and can only be absorbed in longer terms; therefore longer projects are more cost effective.
- Dedicated Intermediaries, like Inspectors in the Agriculture Domain, can play a crucial role in this area as they are in contact with industry professionals, who do not have the adapt knowledge.
- National Contact Points (NCPs) of the Environmental Protection Agencies (EPAs) network should be closely involved.

#### 2.2.3 The Interest Group of Citizen Science of the EPA Network

Jose Miguel Rubio (EEA) presented the Interest Group of Citizen Science's (IGCS) work programme. It aims at analysing the contribution of Citizen Science to environmental policy implementation, the contribution to engagement and empowerment and on

sharing knowledge and experiences across the members. Main items of the presentation included:

- The Role of EPA: it acts as contributor to the development of projects/initiatives/policy documents and guidelines, as facilitator, gather feedback, and promote engagement.
- EPAs work is crucial (13 representatives) and there is an Interest Group on CS how CS can deliver to EPAs Objectives.
- Interest Group on Citizens Science (IGCS representatives are involved in different CSs projects and networks.
- ISCS work programme is reviewed and endorsed annually and it is focusing on reporting, compliance and the SDGs.
- ISCS holds regular meetings.
- The new EPA Network Citizen Science activity acts in the domain of air quality in schools: CleanAir@School. The EEA is coordinator of this activity, as well as a co-chair of the IGCS.

### 2.2.3.1 Questions and Answers

- Q. Will EPA put some money in initiative on Air Quality and CS?  
A. This is the responsibility of the different network members.

### 2.2.3.2 Additional Considerations:

- CS empowerment is useful to make better decision reach higher relevance, and this will be features in the guidelines.
- We should walk away from engagement to empowerment by giving citizens the means to understand and be able to provide input for better decision making.

## 2.2.4 Citizen Scientists and policy makers: a connecting ecosystem

### 2.2.4.1 Citizen Scientists and policy makers: presentations

This session consisted of 3-4 examples of practices and challenges from Member State authorities, NGOs.

Christina Pykonen – German Environment Agency

- Compared different apps; while *zahltag2018*<sup>2</sup> application was not too well known, an initiative on Sensors to assess indoor air pollution was tested successfully in a school.
- Main message: the project should be kept simple and try to get as much data as possible which is relevant to the public.
- Challenges remain when it comes to quality assurance and its enabling conditions that too often still have to be established.

Toos van Noordwijk – EarthWatch Europe

- Despite the project is finishing, they managed to keep the platform going and sustainable thanks to the many spin-offs stemming from the project itself.

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<sup>2</sup> <https://zaehltag2018.de>

- Main considerations: CS provides new info and create new opportunities for new research/project.
- Main messages: Trust building and Recognition of contribution to the issue from PAs and relevant agencies is fundamental for long term sustainability.

Steffen Fritz – IIASA Austria

- Main messages: IIASA is researching and providing global assessment models to government and it benefitted a lot from CS crowdsourcing, games and media campaign to complement their data needs and come to better overview and related modelling.
- The LandSense engagement platform is GDPR compliant, federated, private Apps can plug in and easy to use and contribute to.
- Quality becomes an issue and provided protocols for quality assurance.
- Need for new paradigms in ecology, economy, and societal growth.

Petr Vorisek – European Bird Census Council

- Key issues: EBCC is an association on bird monitoring in EU and use data in science and policy.
- Respect specificities while standardising basic methodologies.
- Train the local citizen scientists.
- Support Open Access while respecting Data Ownership of NGOs, etc.
- NGOs are key to the process especially for policy use and need support as CS is cheap but not for free.

#### 2.2.4.2 Citizen Scientists and policy makers: group work on key issues and recommendations

In this session, groups of 4-6 people were formed to work around the following **Core Questions** previously identified and selected by the Co-organizers circulated before the event, and subsequently agreed with the participants in the WS.

Participants of the working groups were asked to work also on the identifications of responsibilities, concrete actions, and recommendations for each of the issue addressed.

### Core questions provided by the organisers for the two sessions

#### Session 1: Citizen Scientists and policy makers

**Group 1.1:** *How to support the CS communities/NGOs in their key role to enable Environmental Citizen Science?*

**Group 1.2:** *How to balance and shape the level of involvement of public authorities (such as EPAs), e.g. to enable policy impact but avoid top-down behaviour (or perception thereof)?*

**Group 1.3:** *What are good practices to provide feedback about the use of CS contributions to environmental monitoring and how do citizens perceive the use of their inputs?*

**Group 1.4:** *How to measure the benefits of Environmental CS, not only in economic terms but also in terms of transparency, behavioural change and active citizenship?*

**Group 1.5:** *What can we do to ensure data credibility and are there implications on data ownership?*

## Session 2: Citizen Science across geographic scales

**Group 2.1:** *What can we learn in terms of governance from existing CS platforms, esp. in respect to the integration of CS data with other environmental information?*

**Group 2.2:** *What is needed to successfully link the local and European dimension (and even global), and which stakeholders should be involved in different roles?*

**Group 2.3:** *Which capacities (skills and resources) are needed for different stakeholders? What can I offer? What would I need from others? How do we get there?*

**Group 2.4:** *What is good enough for making CS data usable for of public authorities (such as EPAs)? For example, how do the dynamic of projects (e.g. continuous data generation) relate to the fitness of use of contributions for policy making?*

**Group 2.5:** *How to enable interoperability (given different jurisdictions, data availability across environmental domains, culture, and geographic scale)? Considering that interoperability has technical, structural, organisational and legal dimensions.*

**Group 2.6:** *Which role might Artificial Intelligence and Earth Observation play to make CS more relevant for environmental monitoring and reporting?*

Group discussions were guided by a template that requested to complete three main dimensions, namely:

- What are the main/fundamental issues to be addressed/analysed in the given Core Question?
- What it was needed in order to address those issues?
- What are your recommendations for concrete actions and related responsibilities in terms of actors both at National/local as well as EU level?

The group work was followed by the reporting by one member of each group of the conclusions stemming from the discussions. These findings are provided as Annex 3 to this report. The content of discussions and related conclusions and recommendations were further discussed jointly with all participants in the workshop. Summary of discussions

### 2.3 Guidelines for environmental monitoring and reporting

The Workshop revealed to be instrumental for both the presentation and validation of the skeleton of the CS guidelines on environmental monitoring and the related Roadmap. The initiative was very well received; it was felt that an EU regulatory framework for citizen science is useful to help its mainstreaming, implementation and to allow structured connections to be established between citizen science communities and policy makers also at national level. Participants were enthusiastic to be able to directly and concretely participate in the development process of the guidelines and provided a number of very useful and concrete comments and suggestions.

The following issues, in particular, are **concrete suggestions that the Responsible EC Services intend to integrate in the suggested CS Guidelines for environmental monitoring**:

- ✓ The Commission should focus on actions with a cascading effect, e.g. the **use of "champions"** to promote the concept of citizen science
- ✓ Investing in **communication** is key for the integration of citizen science into policies, including focusing on **trust building**

- ✓ It is important that citizens receive feedback on the way their data is used, the more **personalised the feedback**, the more efficient it will be
- ✓ The Commission could promote **a working group to develop a common framework for assessing the impact of citizen science activities**, to promote a more homogeneous and simplified evaluation (also of cost & benefits); the social impact – not only the economic one – should not be forgotten
- ✓ The Commission can bring a big added value in **helping sharing best practices**, and could initiate a training to public authorities (from local to national) on the use of citizens data into policy design, monitoring and evaluation
- ✓ Citizen science communities still lack experience in **sustainable business models**;
- ✓ **multi-level governance** are often the most successful approaches
- ✓ **Private sector support** and involvement in citizen science is unexploited, and some form of **public recognition** (e.g. and Ecolabel for Citizen Science?) could help trigger it

## 2.4 Presentation of initiatives and practices

Participants in the workshop were enthusiastic to learn about to the number of initiatives both at international, as well as at local level that are currently running or are planned by both, international bodies and local NGOs or authorities in order to support environmental monitoring.

This indicates that the **need for CS practices to be applied to policy making is equally felt at both international as well as national level**, and relevant stakeholders are active, each with its specific role and geographical coverage, and seeking for synchronisation, complementarity, and promotion of joint efforts.

One of the main issues identified in this respect is **how to achieve synchronisation of efforts in order to achieve impact, scalability and sustainability, while maintaining relevance to the objectives, targeted communities and policy areas**.

Presentations of the different initiatives and practices are enclosed to the report.

## 2.5 Core questions and related reflections by working groups

The conclusions stem from the discussions that took place in the different working groups working on the Core Questions, They identified concrete topics, made suggestions how to address them, laid out responsibility of action at different levels, and the role of identified stakeholders.

The group results were discussed in a plenary. After the meeting, the material was transcribed, and the outcomes cross-checked with the moderators of each group.

The group were provided common guidelines to frame the discussions, but were free to adapt according to the dynamics in each individual group. Also, due to the nature of group work, the results differ in formulation.

Details of discussions held in the Working Groups are enclosed in Annex 3 to this report.

## 3 Main findings and recommendations

This workshop has been instrumental in demonstrating how CS approaches can be beneficial to policy making processes – including, but not limited to, environment-related policy. As successful CS activities bear mutual benefit for all actors, this workshop provided an important contribution to an EC Staff Working Document currently in preparation, on how CS can complement monitoring and reporting in the environmental

domain. This may also provide a spring board for the promotion of the deployment of CS in other policy domains.

From the analysis of the contributions provided by the eleven Working Groups, a number of essential findings, cross-cutting and interrelated needs should be highlighted. Furthermore, we summarize the recommendations from this workshop before concluding this report.

### 3.1 Main findings

At least as far as the environmental domain is concerned, the discussions confirmed that there is a **clear need for thoroughly examining the observed complementarity and multilayer relationships** between CS and the monitoring and reporting mechanisms. It was recognised that such relationships go far beyond CS contributions to traditional reporting requirements for environment-related policies.

We identified the following core messages related to the overall landscape of CS:

- In order to promote CS approaches and build a favourable environment for them to operate and develop in Europe, it is fundamental that the **public institutions recognise (1) the benefits** brought by CS to policy and related decision-making processes, **and (2) the needs** to put dedicated strategies in place in order to allow CS stakeholders to operate in a collaborative, sustainable and impactful fashion.
- CS approaches have proven to be **relevant, desired, and useful for decision making**. Many great cases do exist already, especially in the EU. However, the many benefits of complementary approaches to knowledge creation are not enough **known, applied, or supported** by public institutions, academia, civil society and industry.
- This is partly due to the fact that **CS initiatives are highly diverse**. They operate within different socio-political contexts and with diverse objectives, creating a complex and dynamic ecosystem that involve high numbers of different actors (stakeholders), each with their own roles and responsibilities. In this landscape, different governance models and approaches are applied to different domains and for different purposes - always depending on the scale and relevance of the initiative.
- Thus, it remains neither easy to find the way to collaborate to the best possible extent, nor to identify best practices. It is obvious that, given these settings, **there is not one single way to connect, for example, CS and environment policy**.
- Accordingly, there is a clear need to **identify CS initiatives and develop a clear mapping of all actors and stakeholders, and their level of involvement at different geographic scales (administrative levels)**. This mapping should lead to an understanding of the actors' roles, applied approaches, and responsibilities, their dynamics, and how collaborative schemes can be initiated or improved. Dedicated research is needed in order to understand the dynamics in a multi-cultural environment, and behavioural changes appearing in the short- mid- and long-term.
- Overall, **challenges need to be addressed more systemically**, and to help potential participants to acknowledge and to get engaged in CS, the benefits brought about by different CS approaches need to be clearly identified, spelt-out and communicated to the different audiences. Successful collaboration between citizen, scientists and public institutions will be reached only if all participants clearly see how they benefit from the joint efforts.
- There is a need to develop **shared CS assessment frameworks** – in support of identifying and setting up CS activities, but also for the tracing and review of their

impacts. Such frameworks would need to be adaptable to the different contexts (geographical scale and relevance of issue addressed), and would have to consider both, the direct and the indirect/intrinsic benefits of CS approaches (e.g. educational and behavioural change in citizens and politicians). The impact assessments should distinguish between outputs, outcomes and (positive and negative) impacts.

- There is a clear need to investigate possibilities and limits of approaches including CS in policy to **spread** (from one local application to another) and to **scale** (considering implications materialising in the transition from local to regional, national and international levels).
- The current and **evolving influence of digital technologies** (datafication and platformisation of society) deserves dedicated attention. It does not only offer opportunities for more efficient and effective knowledge creation and exchange – which is especially relevant when talking about the EU-wide context – but also introduces **technical, organisational, legal and ethical challenges**. The interface between CS and Artificial Intelligence (esp. incl. machine learning) is one emerging area of research. So is the possible interplay with digital government, and digital social innovation.

In addition to these overarching statements, we also identified elements that relate to each CS approach in its own, including:

- Each CS approach faces **a number of rather technical challenges**, from the clarification of the *fit-for-purpose* of the created knowledge, via the need for interoperable tools and methodologies, to dilemmas between standardisation and the required flexibility of solutions. This implies a strong need to take a number of well-educated choices when setting up a new CS activity, and suggests the need of an assessment framework that supports the required decision-making processes.
- For a CS initiative to successfully impact policy (if intended), it has to be relevant and **fit to the intended purpose**. CS initiatives can have different policy impacts, and the nature of each initiative defines the possible relationships. Clear differences exist, for example, between a CS contribution to activate communities and to create political pressure, CS activities that inform policy of potentially emerging issues, and CS data that is used to monitor policy implementation. To give an additional example, the use of the data provided by Citizen Scientists (alone) may not be considered of sufficient quality for one objective, but could very well be used for a different purpose (e.g. the national-level annual reporting about domestic waste, as compared to, the spotting of illegal dumping sites). Depending on the different possibilities, different **data quality** aspects and the according **quality assurance frameworks** need to be in place, and they need to be well documented.
- **Improved standardisation and the increased use of these standards** would help to reach a wider spread of CS approaches and to re-use of existing solutions, including data models, sharing principles, as well as, quality assurance methodologies. Standards would also help to assess the “fitness for purpose” of a given CS initiative to particular policy-related decisions.
- In this context, **interoperability** needs to be well address by carefully assessing the benefits and drawbacks (e.g. costs) of specific solutions before taking measures. In this respect, interoperability frameworks are essential, and it has to be clearly identified what enables interoperability (e.g. taxonomy), and for whom the desired interoperability will be useful (different cultural habitats). The assessment should consider different scenarios of what will be made interoperable and how – together with an analysis of their benefits and drawbacks. Established terminology of different communities (and cultures) has to be preserved, while

enabling translations between them so that these communities can understand each other.

Last but not least, we can derive a number of observations relating to the **interplay between the different kinds of involved stakeholders**. These include:

- Existing **governance models** need to be mapped and further developed according to the different objectives, contexts and intended use by different stakeholder groups. The new developments should pay particular attention to possible differences that emerge from bottom-up as compared to top-down approaches. The willingness and capability, but also the risks, to change existing power relations are key issue to address.
- These governance models need to include clear principles and realizations for **knowledge and data management - grounded in principles of co-creation and sharing**.
- **Commitments** must be in place and clear from all sides, the public sector, NGOs, citizen and other stakeholders.
- The **required level of continuity of particular collaborations** depends on the issue(s) at stake. Pressing challenges might evolve and vary over time. Also the expectations and responsibilities of the partnerships may change over time, but they should always be clear – from the very beginning to the eventual end. This also includes the awareness and acknowledgement of diverse (legitimate) motivations and intentions why actors participate in a joint endeavour.
- **Feedback mechanisms** need to be identified and put in place, to keep engagement of stakeholders and develop trust in the public institutions. Rising **transparency** on the objectives and use of CS data, will allow different stakeholders to evaluate their interest for participation, track and validate their contributions and related impact on policy making processes - at local level, as well as, at national and international levels.
- Workable solutions are needed in order to **ensure legal access** (who is allowed to access certain knowledge, under which conditions both, per country and across the EU) **and adequate physical access** (for knowledge that can be accessed anytime from anywhere, and for data that might need physical restrictions to be put in place, e.g. to protect privacy).
- **NGOs have a critical role** in connecting the different stakeholders, sharing good practices, and facilitating collaborations. This also includes the dissemination of interoperable assets (such as standard processes, tools, methodologies, training material and other resources).
- **Governmental support and endorsement** of the above mentioned interoperable assets are key in order to enable and ease the uptake of CS for environment-related policy, and in other policy fields. Such governmental support is a pre-requisite for CS approaches to be applied and eventually mainstreamed to a number of policy areas. This political support has to come along with long-terms strategies and sustainable funding models - at EU MS, and regional level.

### 3.2 Recommendations

The workshop participants identified the following **recommendations** considering particular targeted audience. Notably, due to the nature of the workshop, these recommendations vary in level of detail and granularity. Also, most recommendations are formulated in a way that addresses Citizen Science general, and are not limited exclusively for activities in the environmental domain.

- **The organizers of any Citizen Science initiative (independent of who they are)**, have to ensure up-front that the roles and responsibilities of all participants are clarified. This should be done by specifying pro-active as well as re-active roles, and by considering the different views and goals of the different actors, identifying possible conflicts, and accounting for issues such as data ownerships and other legal matters.
- **Public authorities** may wish to review the requirements for (environment-related) reporting and more relevant mechanisms and pathways established in view of the opportunities offered by Citizen Science.
- **Public authorities** should be honest and clear about the purpose for which CS data will be used, and where it will not be used, including reasons why (biases, spatio-temporal coverage, etc.)
- **Public authorities** should be pro-active in using standard and interoperable solutions in order to make CS data good enough to be useful and usable for them. This includes a clear definition of their actual needs (specific open questions), endorsement of QA/QC standards and procedures applied by CS initiatives, provision of knowledge and access to required data and methodological standards, support to the definition of data acquisition methods and protocols, easy access and visualisation of data already available.
- **Public authorities**, and **CS initiatives** alike, should acknowledge that data (and data from CS is not exception) can be used by public authorities for different purposes, such as filling data gaps, getting a better sense of the perception of a certain thematic area, validation of environmental modelling, etc.
- **Public authorities**, and **CS initiatives** alike, should consider moving beyond one-directional data provisions, for example, by entering into dialogues why and how certain contributions could (or could not) be used. Such dialogues should also be considered as an opportunity to address the actual thematic area under consideration.
- **Public authorities**, and **CS initiatives** alike, should acknowledge existing procedural barriers, i.e. understand the need for a mutual learning progress in which new skills have to be acquired and mistakes will be made.
- **CS initiatives** should acknowledge that (as for any other data) also CS data needs to follow certain standards in order to be useful and usable by public authorities, this especially includes the documentation of applied QA/QC processes and possible biases in the data, as well as, the application of data and methodological standards.
- **Citizen Science networks** (in collaboration with each other on national and international level) should help to identify and (if needed) develop software solutions for regular and personalised feedback, so that every participant can get informed also about his/her contribution (to science but also to environment-related policy), and the overall topic area, in their preferred amount and format.
- **Citizen Science networks** should help to channel efforts in CS, including (i) acknowledgement of the different values (possible uses) of contributions, such as value for science, society, policy, public authorities, economy, (ii) pedagogical training for Citizen Science coordinators related to feedback and information dissemination.
- **Citizen Science networks** might develop clear guidelines for acknowledging data contributions for ensuring long term engagement methodologies and sustainability plans.
- **Citizen Science networks** might develop guidelines and recommendations on the use of mobile apps and that this use needs to be evaluated up-front as a CS App is a means not a goal, and should be used in a context of CS dedicated social

networks/fora. If a mobile application is indeed considered as the best approach, re-use of existing apps should also be considered.

- **Citizen Science facilitators** should define and share common methodologies and a toolbox for regular dissemination, feedback, reporting, and data validation – in order to support the entire lifecycle of CS contributions (to environment research and policy). This should include regular feedback, during the CS activity, data treatment, and data use, but also clear statements about the potential use (and not use) of the contributions beforehand – as far as known. Expectation management is of central importance. At least as far as data validation is concerned dialogues should be supported (not only one directional information flows about the 'status' of a contribution).
- **Intermediaries** (i.e. third-party actors, such as NGOs) should provide user friendly tools (such as data bases for integrating CS data with the current data holdings of public authorities), training and capacity building for both CS initiatives and public authorities, and provide the required coordination capacities.
- **Data governance experts** could develop and provide a framework (policies and mechanisms) to deal with data ownership, so that participants remain in control of their own contributions, including the freedom to decide on the use of his/her contribution. The actual tracing and compliance assurance with the (intended) use of contributions, e.g. in science and policy, needs to be particularly considered.
- **ESA and JRC** might organise a hackathon in order to stimulate/promote the development of dedicated tools for dynamic AI/EO (i.e. services for interpreting data) should be integrated in CS apps. The challenge is for a lightweight app, often used in the field with limited bandwidth, to access powerful AI functionality via a web service, in a timely fashion which allows the activity to remain interactive and engaging.
- **ECSA and the EC could create a working group** to lead in the development of the assessment framework, also by identifying and taking into account the many projects already investigating related aspects that would also compile and take examples/lessons learned by other Communities (Open science and open data, Ecosystem services, Value of information theory, MOORI indicators, SwafS, WeSenseIt, CA 15212 WG 5 on CS ontologies,...).

In addition to these specific recommendations from the workshop, and due to temporal constraints, the following **additional needs** were identified without the scoping of more concrete actions and possible actors. They might be taken up in future work.

- There is a need for **mapping the different governance models**, what it is currently being used for their implementation (e.g. by ECSA and others -projects such as OPAL), find out to which extent, and with what results/impact. With the ultimate aim being **scoping and sharing successful approaches and good practices**.
- There is a need for **encouraging governance models and approaches that increase interoperability and sharing processes**, while respecting critical/sensitive data (e.g. personal data/data from private locations), and that **facilitate integration** of/into other operational platforms and open/closed services.
- The issue is complex involving different aspects directly affecting the approaches and related results, for example, the fact that different projects have very different quality goals, results affected by the mixed demography of participants, data ownership, data conservation, data complexity and the risk of duplication/reinventing the wheel. For this reason **data quality, (re)use, conservation, and acknowledgement need to be addressed in a holistic way**.

- We suggest a **systematic two-stage process in policy making including CS community** since the beginning, as a possibility for increasing interoperability and facilitating integration amongst the different stakeholders their methodologies and relevant platforms. This approach implies in the first place getting together policy-makers and CS practitioners working in the same area, to compare and share information about their activities, objectives, databases and data. Then, based on the lessons learnt from the comparison exercise, they could try to develop collectively governance models and procedures for future work, so that CS data would meet policy objectives and feed more effectively and efficiently into official databases. In this way, CS data will have a greater value to and greater influence on policy processes.
- To generate maximum impact, **scalability of projects should be built in from the start**. It is key to 1) consider how needs and opportunities may change at larger scales, 2) involve key stakeholders from different scale levels and locations from the start and 3) mobilise funders at different scales. This creates channels and funding opportunities that enable connection of different scales.
- There is a need to **connect local initiatives and raise awareness of the potential** of both local and large-scale initiatives to the public and among governments. This is necessary for help the spreading of successful approaches. It implies needs for suitable approaches, including the mobilisation of funders at different scales.
- Once the ecosystem and interrelations are identified and understood (including both institutional and other actors) there is also a need for **dedicated trainings for each of the relevant actors need to be conceived**. These trainings have to address both, the specific needs to allow each actor to fulfil his/her specific role, as well as the needs for collaborating with of the other stakeholders. Training of the latter should particularly address the awareness of ethical values and trust-building between different parties, but also the manifold issues related to data management.
- Still regarding training we see a particular need to emphasize that continuous **engagement** can be facilitated by applying **transparency and establishing a balance of power**. Required skills include appropriate project management skills, the appropriate handling of the ownership of data and of ideas, and the capacity to provide feedback to Citizens Scientist on the use and impact of their contribution.
- There is a clear need to **increase research to understand behavioural change and cultural dependencies thereof**. How can we reach interoperability while still benefitting from the cultural diversity in Europe?

### 3.3 Conclusions

The two main objectives of the workshop were met: providing input and feedback to an action of the DG Environment "Action Plan to Streamline Environmental Reporting" together with valuable hints to the related roadmap, and identify what the main influencing factors are, that would nurture CS approaches and promote their deployment into policy making processes.

With regard to the above action plan, it was highlighted on several occasions that CS can make a substantial contribution in complementing and in supporting environmental monitoring and reporting and. Consequently, CS can also help to address the SDGs, given that required investments are provided for capacity building. In this respect, capacity building comprises technical issues, such as infrastructures for data and standards, but also soft skills such as trainings for volunteers, quality control and careful management of the social networks.

In addition, the potentials of CS have to be clearly stated. It cannot be repeated often enough that CS not only contribute data, but – also thanks to the rich portfolio of CS approaches – Citizen Scientists can be involved to different degrees in priority setting; participate in the creation of methodologies; validate, analyse, and interpret scientific observations and experiments; and catalyse societal participation in policy. In this respect, the European institutions might want to support the development of favourable conditions, in political, administrative, legal and technical terms by developing relevant frameworks around common issues (such as interoperability arrangements, standardisation, engagement methods and tools, quality assurance methodologies, and assessment frameworks).

With respect to the critical factors that strongly influence and determine the uptake and development of CS in support to policy making both, at European as well as at Member States level, these were found to be (in order of priority):

- i) awareness of the benefits of CS contributions to policy making;
- ii) a clear understanding of possible contributions of CS both at European and national level;
- iii) political willingness and long term support through sustainable funding and planning.

With respect to the technical and scientific aspects, it was confirmed that further research and the developed of guidelines on horizontal issues like interoperability, standardisation, quality, indicators and measurement frameworks are needed.

It was also acknowledged that the role and potentialities of NGOs, and other similar organisations, is often underestimated; these play a crucial role acting at the interface between citizens, science, and political administration, and they would need more attention and resources for their potential to be fully exploited. In addition, the insights from science also support the integration of CS in environmental monitoring. In the CS COST Action 15212 for example, a pool of experts comes together and work on ontologies, gender issues, and on the transformative potential of CS. Opportunities for exchange between the practitioners, policy makers, and science communities, brought about by this workshop, is therefore extremely helpful for allowing an educated and concrete follow-up of collaborative work.

All participants in the workshop filled-in a feedback form that had previously been distributed. From the **analysis of the feedback forms**, the following overall appreciations about the workshop can be drawn:

The workshop was very well perceived with respect to all its dimensions, namely: content, relevance, usefulness of activities, networking opportunities, timing and experience.

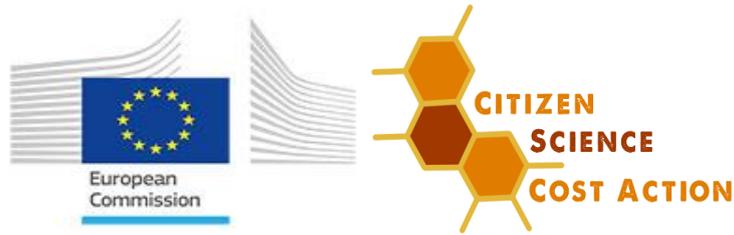
Participants gained mostly in terms of understanding, awareness, knowledge sharing, issues insights, exposure and networking. In this respect our objective to provide a common ground with mutual benefits was fully achieved.

A summary of the analysis of the feedback that we received is enclosed as Annex 4 to this report.

## **Annex 1. Abbreviations used in the context of this Event**

<b>AI</b>	Artificial Intelligence
<b>COST</b>	Cooperation in Science and Technology (EU Programme)
<b>CS</b>	Citizens Science
<b>DG ENV</b>	Directorate General for Environment (European Commission)
<b>EBCC</b>	European Birds Consensus Council
<b>EC</b>	European Commission
<b>ECSA</b>	European Citizens Science Association
<b>EEA</b>	European Environmental Agency
<b>EO</b>	Earth Observations
<b>EOCS</b>	Earth Observation and Citizens Science
<b>EPA</b>	Environmental Protection Agency
<b>EU</b>	European Union
<b>GDPR</b>	General Data Protection Regulation
<b>GEO CA</b>	Global Earth Observation Contractual Agreement
<b>IAS</b>	Invasive Alien Species
<b>IGCS</b>	Interest Group of Citizen Science of the EPA Network
<b>JRC</b>	Joint Research Centre (Directorate General of the European Commission)
<b>MC</b>	Management Committee
<b>MoRRI indicators</b>	RRI indicators collected through the MoRRI Responsible Research and Innovations project
<b>NCPs</b>	National Contact Points
<b>NGOs</b>	Non-Governmental Organisations
<b>OPAL project</b>	OPAL (for "Open Algorithms") is a non-profit socio-technological innovation
<b>QA</b>	Quality Assessment
<b>QC</b>	Quality Control
<b>SDGs</b>	Sustainable Development Goals
<b>SwafS</b>	Science with and for society projects within the EU H2020 Research Programme
<b>WeSenseIt</b>	Citizen Observatory of Water EC FP7 Research project

## Annex 2. Meeting Agenda



### COST WG 3 Workshop: Citizen Science and Environmental Monitoring: Benefits and Challenges

**Date:** 21 and 22 November 2018 (half-day overlap with COST Action meeting on CS and Invasive Alien Species, and one full working day)

**Location:** JRC, Ispra, Via Enrico Fermi 2749, Italy.

Citizen Science is experiencing a twofold positive development in its arena. On the one hand, the many and impressively evolving communities engaged in Citizens Science activities, get better and better organized. On the other hand, policy makers increasingly recognize the potential of Citizen Science as a precious and novel source of information in support to environment-related policies.

Notably, the European Commission's Actions to Streamline Environmental Reporting (COM(2018)10) promote the wider use of citizen science to complement environmental reporting (Action 8), and provides an unique opportunity to contribute to the drafting of guidelines on *how Citizen Science and environmental reporting can be interconnected and mainstreamed in policy making*.

This workshop represents an excellent and timely opportunity to host both stakeholders groups together, to discuss and elaborate on the opportunities and challenges brought forward by the increasing need and use of CS approaches in support to policy making.

The **expected outcomes** from these two days collective work is: to gather expert feedback on both, the proposed roadmap to develop guidelines about the relationship between Citizen Science and environmental reporting; achieve better clarity about the degree of needed engagement; present good practices and ideas on what stakeholders can do in order to offer this desired degree of engagement equally and consistently across the EU.

Its ultimate goal of the Workshop is to provide recommendations on the way forward in improving and accelerating Citizens Science developments throughout Europe.

#### **Organization Committee:**

- Marina Manzoni (European Commission - DG Joint Research Centre - JRC)
- Sven Schade European Commission - DG Joint Research Centre - JRC)
- Katrin Vohland (Chair of the Citizen Science Cost Action CA 15212, Museum für Naturkunde Berlin)



## WORKSHOP AGENDA

<b>21 November 2018 (Wednesday)</b>	
<b>11:30 Guided Tour at the Visitor Centre of the JRC</b>	
12:00 – 13:00	<b>Conclusions from the meeting</b> “Strengthening the link between Invasive Alien Species (IAS) apps data and policy: Development of an appropriate governance framework” and introduction of the excursion (Ana Cristina Cardoso, JRC.D.2, t.b.c.)
13:00 – 14:00	<b>Networking lunch</b> (with participants of the meeting “Strengthening the link between Invasive Alien Species (IAS) apps data and policy: Development of an appropriate governance framework”)
14:00 – 15:30	<b>Excursion in groups</b> for field activities and testing using multiple approaches to gather Citizen Science data
15:00 – 16:00	<b>Feedback</b> from the groups (Eugenio GERVASINI, JRC.D.2, t.b.c.)
16:00 – 17:30	<p><b>Introduction to the workshop “Citizen Science and Environmental Monitoring: Benefits and Challenges”</b></p> <p>(Moderators: Katrin VOHLAND, Chair of the Citizen Science Cost Action CA 15212, Museum für Naturkunde Berlin; Marina MANZONI, JRC B.6)</p> <ul style="list-style-type: none"> <li>• Introduction to the COST Action 15212 and WG3 (Katrin VOHLAND, Chair of Citizen Science Cost Action)</li> <li>• Meeting objectives (Sven SCHADE JRC B6)</li> <li>• Tour de table - participants expressing their expectations from the Workshop and sharing info on relevant upcoming actions</li> <li>• Wrap-up and fine-tuning of goals for the next day</li> </ul>

## 22 November 2018 (Thursday)

09:00 – 10:45	<p><b>Scene-setting for the day</b> (Moderator: Marina MANZONI, JRC B.6)</p> <ul style="list-style-type: none"><li>• Impressions from the previous day (Tour de table)</li><li>• Set-up for the day: Agenda of the day (Katrin VOHLAND, Chair of Citizen Science Cost Action)</li><li>• Highlights from relevant EC activities, including recent inventory of citizen science activities for environmental policies (Sven SCHADE, JRC B.6)</li><li>• Scene setter on <b>Action 8: "Promote the wider use of citizen science to complement environmental reporting"</b> within the EC <i>Action Plan to streamline environmental reporting</i> (Elena MONTANI, DG ENV A.3)</li><li>• The Interest Group of Citizen Science of the EPA Network (Jose Miguel Rubio, EEA)</li></ul>
10:45 – 11:00	<b>Coffee break</b>
11:00 – 13:00	<p><b>Citizen Scientists and policy makers: a connecting ecosystem</b> (Moderation by Jose Miguel Rubio EEA)</p> <ul style="list-style-type: none"><li>• 3-4 examples of practices and challenges from Member State authorities, NGOs, etc.<ul style="list-style-type: none"><li>✓ Christina Pykonen – German Environment Agency</li><li>✓ Toos van Noordwijk – EarthWatch Europe</li><li>✓ Steffen Fritz – IIASA Austria</li><li>✓ Petr Vorisek – European Bird Census Council</li></ul></li><li>• Group work on key issues and recommendations (3-5 groups appx. 1 h.)</li><li>• Reporting back from the groups</li></ul>

	<ul style="list-style-type: none"> <li>• Joint discussion and reflections</li> </ul>
13:00 – 14:00	<b>Lunch break</b>
14:00 – 15:45	<p><b><i>Citizen Science across geographic scales: opportunities and challenges</i></b> (Sven SCHADE, JRC B.6)</p> <ul style="list-style-type: none"> <li>• Voices of stakeholders involved at different geographic scales: local, regional, national, EU level <ul style="list-style-type: none"> <li>✓ Jaka Kranjc – <i>Let's do it World</i></li> <li>✓ Rosa Arias – <i>D-NOSES</i></li> <li>✓ Marijn VAN-DER-VELDE <i>LandSense</i> – EC JRC</li> <li>✓ Johan Nilsson <i>Artportalen</i></li> </ul> </li> <li>• Group work on key issues, successful scenarios and frameworks (3-5 groups appx. 1 h.)</li> <li>• Reporting back from the groups</li> <li>• Joint discussion and reflections</li> </ul>
15:45 – 16:00	<b>Coffee break</b>
16:00 – 17:45	<p><b><i>Conclusions and way ahead</i></b> (Co-moderated by Katrin VOHLAND and Marina MANZONI)</p> <ul style="list-style-type: none"> <li>• Wrap-up of main points</li> <li>• Final comments from participants</li> <li>• Discussion of next steps</li> <li>• AOB</li> <li>• Closure of meeting</li> </ul>

## **Annex 3. Core Questions and related reflections from the Working Groups**

The conclusions stemming from the discussions that took place in the different working groups about the set of **Core Questions** were encouraging in terms of concreteness of identified issues to be addressed for each of the core questions, and the related suggestions on how to address them, responsibility of action at different levels, and the role of identified stakeholders. The group results were discussed in plenary. After the meeting, the material was transcribed, interpreted by the others of this report, and the outcomes cross-checked with the moderators of each group.

The group were provided common guidelines to frame the discussions, but were free to adopt according to the dynamics in each individual group. Also, due to the nature of group work, the results differ in formulation and detail.

### **Session 1: Citizen Scientists and policy makers: a connecting ecosystem**

**Consolidated findings from Group 1.1:** *How to support the CS communities/NGOs in their key role to enable Environmental Citizen Science?*

- **Political willingness** is the first prerequisite in order to promote the benefits of CS practices, and for its approaches to be developed and applied to policy making.
- **A clear mapping of Actions/strategies/initiatives, related Actors** with their roles and responsibilities, as well as working dynamics and Governance, need to be carried out to set the basis for outlining the state of the art of CS development across the European Countries.
- **Long terms sustainable plans** are needed including consultation and awareness campaigns and the use of "champions" as catalysts/facilitators for the promotion of CS Good Practices and their uptake by local communities/actors.

**Consolidated findings from Group 1.2:** *How to balance and shape the level of involvement of public authorities (such as EPAs), e.g. to enable policy impact but avoid top-down behaviour (or perception thereof)?*

- **The involvement of different actors at different level** (institutional and non-institutional) proved to be beneficial in terms of visibility and promotion of activities and guidance in the methodologies, and clear basis for collaboration needs to be sought and set at all levels.
- A **successful collaborative partnership needs to be clarified up-front** in terms of roles and responsibilities by specifying in terms and in turn pro-active versus re-active roles, in view also of the different goals of the different actors, and also to address issues like Data Ownerships, legal issues and, sometimes, conflicting goals
- A **balance between top-down versus bottom-up governance needs to be found** based on a preliminary clarification of roles and responsibilities. Only this way a win-win relationship can be established building on each-other strengths
- There is a clear need for **reviewing the requirements for reporting** and more relevant mechanisms and pathways established
- There is a clear need for **commitment, from both sides**, in terms of time and finances, provision of relevant expertise, and communication improvement.

**Consolidated findings from Group 1.3:** *What are good practices to provide feedback about the use of CS contributions to environmental monitoring and how do citizens perceive the use of their inputs?*

- **Citizen Science networks** should help to identify and (if needed) develop software solutions for regular and personalised feedback, so that every participant can get informed also about his/her contribution, and the overall topic area, in their preferred amount and format.
- **Citizen Science facilitators** should define and share common methodologies and a toolbox for regular dissemination, feedback, reporting, and data validation – in order to support the entire lifecycle of CS contributions. This should include regular feedback, during the CS activity, data treatment, and data use, but also clear statements about the potential use (and not use) of the contributions beforehand – as far as known. Expectation management is of central importance. At least as far as data validation is concerned dialogues should be supported (not only one directional information flows about the 'status' of a contribution).
- **Data governance experts** to develop and provide a framework (policies and mechanisms) to deal with data ownership, so that participants remain in control of their own contributions, including the freedom to decide on the use of his/her contribution. The actual tracing and compliance assurance with the (intended) use of contributions, e.g. in science and policy, needs to be particularly considered.
- **Citizen Science networks** should help to channel efforts in CS, including (i) acknowledgement of the different values (possible uses) of contributions, such as value for science, society, policy, public authorities, economy, (ii) pedagogical training for Citizen Science coordinators related to feedback and information dissemination.

**Consolidated findings from Group 1.4:** *How to measure the benefits of Environmental CS, not only in economic terms but also in terms of transparency, behavioural change and active citizenship?*

- There is a clear need to develop a **common assessment framework** (for EU projects, public administration, NGOs), based on existing best practices, on how to measure benefits – also ex-ante, by complementing the multi-disciplinary research gap by using social science methodologies and holistic assessment of benefits (win-win situations, storytelling) Value of Information (VoI) research and learning from other communities.
- **ECSA-EC could create a working group** to lead in the development of the assessment framework, also by identifying and taking into account the many projects already investigating related aspects that would also compile and take examples/lessons learned by other Communities (Open science and open data, Ecosystem services, Value of information theory, MOORI indicators, SwafS, WeSenseIt).
- One critical question when assessing the benefit of CS projects is to first understand what additional data is needed and, when collected by citizen, how these can improve decision making processes. We can this way think of two scenarios - namely one without (a baseline scenario) and one with CS data - and look for the difference and the impact that the latter had on that specific decision making process. As an example of CS based approaches benefit, is the improved more informed decision which can be made based on CS data e.g. red list species based on GBIF data just to name one.
- Other benefits are derived from CS projects is improve scientific literacy of people, (e.g. improve critical thinking, learn how to investigate based on data, etc.). The most important aspect is that CS projects can foster behavioural change and lead to transformation. For example the "curious noses" project in Flanders (done by 5 percent of the population), has led to modify driving behaviour and, even more importantly, it has helped to move the public debate from immigration issues to environment and health priorities and this is regarded as a great achievement thanks to this CS project in Belgium.

- There is a clear need to **quantify whenever possible both the direct as well as the indirect or intrinsic benefits** (such as learning different disciplines, enjoying nature, different communities collaborating and learning from each other, enriching and adding value on its own knowledge, supporting Societal Values on top of knowledge sharing, etc.). The indirect benefits can be measured via different approaches (e.g. questionnaires before after project).
- In this respect, there is a clear need to **differentiate between output** (strategies, initiatives, toolkits, methodologies, indicators, multidisciplinary research results, inventories, etc.), **outcomes** (best practices, agreed assessment frameworks, creation of communities of practices, alliances, collaborative approaches, etc.), and **impact**, as this is composed of both, quantitative and qualitative indicators (the latter being the most difficult to assess) that needs also to take into account the socio-economic indirect benefits as well as the social values addressed.

***Consolidated findings from Group 1.5: What can we do to ensure data credibility and are there implications on data ownership?***

- The issue is complex involving different aspects directly affecting the approaches and related results, for example, the fact that different projects have very different quality goals, results affected by the mixed demography of participants, data ownership, data conservation, data complexity and the risk of duplication/reinventing the wheel. For this reason **data quality, (re)use, conservation, and acknowledgement need to be addressed in a holistic fashion.**
- **Reliable and trustworthy data** is essential. Therefore, it is important to involve different actors – including, for example, citizen, scientists, civil servants - in the design, development and testing of data gathering tools (e.g. mobile applications – apps). These different stages of the development cycle should consider community validation together with the development of a sound Quality Assessment Framework. Special care should be taken in terms of access and use conditions, control of personal data, provenance tracking with unique identifiers, common standards for methods and for datasets, as well as, the use and development of open source software.
- **Data can be used, and re-used in different ways** with varying levels of quality provided it is **"fit for use"** by the different stakeholders needing it for different purposes. Ensuring (re)use of data, in different ways for different purposes, decreases the risks of duplication while allowing for more data sharing and collaborative approaches to be established.
- **Training on data management for the different stakeholders** in CS data creation and use (e.g. NGOs, citizens and software engineers), is essential for a common understanding of rules, objectives, roles and responsibilities, collaboration dynamics, data typology, quality and use and the needed assessment framework for evaluating their potential impact. The (possible) relationships to policy content and processes deserve special attention.
- The development of **clear guidelines for acknowledging data contributions** is essential for ensuring long term engagement methodologies and sustainability plans. The same pre-conditions apply for the use of apps as this needs to be evaluated up-front as a **CS App is a means not a goal**, and should be used in a context of CS dedicated social networks/fora. If a mobile application is indeed considered as the best approach, re-use of existing apps should also be considered.

## Session 2: Citizen Science across geographic scales: opportunities and challenges

**Consolidated findings from Group 2.1:** *What can we learn in terms of governance from existing CS platforms, esp. in respect to the integration of CS data with other environmental information?*

- **There are many different governance models and approaches** applied on/by different domains in different ways, for different purposes and depending, for example, on the closeness to politics of particular CS initiatives and/or topic areas.
- One-model-fits-all is not applicable. There is therefore a need for **mapping the different governance models**, what it is currently being used for their implementation (e.g. by ECSA and others -projects such as OPAL), find out to which extent, and with what results/impact. With the ultimate aim being **scoping and sharing successful approaches and good practices**.
- Ultimately there is a need for **encouraging governance models and approaches that increase interoperability and sharing processes**, while respecting critical/sensitive data (e.g. personal data/data from private locations), and that **facilitate integration** of/into other operational platforms and open/closed services.
- We suggest a systematic **two-stage process in policy making including CS community since the beginning**, as a possibility for increasing interoperability and facilitating integration amongst the different stakeholders their methodologies and relevant platforms. This approach implies in the first place getting together policy-makers and CS practitioners working in the same area, to compare and share information about their activities, objectives, databases and data. Then, based on the lessons learnt from the comparison exercise, they could try to develop collectively governance models and procedures for future work, so that SC data would meet policy objectives and feed more effectively and efficiently into official databases. In this way, CS data will have a greater value to and greater influence on policy processes.

**Consolidated findings from Group 2.2:** *What is needed to successfully link the local and European dimension (and even global), and which stakeholders should be involved in different roles?*

- Many CS activities are carried out at local level as these are driven mainly by direct needs and passion. However, CS activities can have wider impact, beyond the local scale. There is a clear need for raising awareness and for clarifying the possible/potential spread of impact to the public and among governments.
- Citizen science activities with strongly involved citizens and clear links to environmental action often operate at local level, as citizens tend to be most strongly connected to and motivated by environmental issues at this scale. Yet such **local activities can have wider impact**, by sharing expertise, good practices and by connecting and scaling-up such activities to increase their reach (and create funding opportunities).
- There is a clear need to **connect local initiatives and raise awareness of the potential** of both local and large-scale initiatives to the public and among governments. This is necessary to support the spreading of successful approaches. It implies needs for suitable approaches, including the mobilisation of funders at different scales.
- To generate maximum impact, **scalability should be built in from the start**. It is key to 1) consider how needs and opportunities may change at larger scales, 2) involve key stakeholders from different scale levels and locations from the start

and 3) mobilise funders at different scales. This creates channels and funding opportunities that enable connection of different scales.

- **NGOs have a critical role to play in connecting different stakeholders** at different levels and at different scales. Stakeholder mapping, monitoring and long-term engagement, therefore, emerge as essential components for identifying and facilitating the different channels and dynamics that need to be connected. Sufficiently resourcing these actors will greatly improve their efficiency, impact and knowledge sharing across scales.

**Consolidated findings from Group 2.3:** *Which capacities (skills and resources) are needed for different stakeholders? What can I offer? What would I need from others? How do we get there?*

- In order to **identify what skills and resources are needed**, it is necessary to understand first of all **who the relevant stakeholders are**, what dynamics of interactions apply amongst them, and how these can be improved in such ecosystem both, at national and local level. In this context, the main stakeholders are namely: Citizens at large, NGOs, academia, private sector, and public sector, in particular policy makers.
- Required capacities can only be identified based on a solid understanding of the dynamics between scientific approaches, policy making, and the actual impacts of Citizen Science interventions and contributions.
- Once the ecosystem and interrelations are identified and understood (including both institutional and other actors) **dedicated trainings for each of the relevant actors** need to be conceived. These trainings have to address both, the specific needs to allow each actor to fulfil his/her specific role, as well as the needs for collaborating with of the other stakeholders. Training of the latter should particularly address the awareness of ethical values and trust-building between different parties.
- **Training tools** should feature common standards, while be flexible enough for adaptation to specific/local needs. When this is not possible, ad-hoc tools (developments/solutions/applications) should be envisaged.
- Also the **acknowledgment and recognition of contributions** deserve particular attention when dealing with skills and resources. These required skills can be developed by organising dedicated trainings for public authorities (find the right 'targets' to make systemic changes), for academia (new courses with certified new curricula, involving top scientists) and for formal education (with formal recognition in educational CVs).
- Continuous **engagement** can be facilitated by applying **transparency and establishing a balance of power**. Required skills include appropriate project management skills, the appropriate handling of the ownership of data and of ideas, and the capacity to provide feedback to Citizens Scientist on the use and impact of their contribution.
- Stakeholders engagement above could be supported by applying, for example, **open governance** systems/models and **participatory planning**, by providing **incentives** and **recognition** to the private sector (e.g. with an "eco label for Citizen Science"), and by developing appropriate/dedicated, well adapted, ready to use **Citizen Science tool kits**.

**Consolidated findings from Group 2.4:** *What is necessary for making CS data usable for of public authorities (such as EPAs)? For example, how do the dynamic of projects (e.g. continuous data generation) relate to the fitness of use of contributions for policy making?*

- **Public Authorities**, and **CS initiatives** alike, should acknowledge that data (and data from CS is not exception) can be used by public authorities for different

purposes, such as filling data gaps, getting a better sense of the perception of a certain thematic area, validation of environmental modelling, etc.

- **Public Authorities** should be honest and clear about the purpose for which CS data will be used, and where it will not be used, including reasons why (biases, spatio-temporal coverage, etc.)
- **CS initiatives** should acknowledge that (as for any other data) also CS data needs to follow certain standards in order to be useful and usable by public authorities, this especially includes the documentation of applied QA/QC processes and possible biases in the data, as well as, the application of data and methodological standards.
- **Public Authorities** should be pro-active in using standard and interoperable solutions in order to make CS data good enough to be useful and usable for them. This includes a clear definition of their actual needs (specific open questions), endorsement of QA/QC standards and procedures applied by CS initiatives, provision of knowledge and access to required data and methodological standards, support to the definition of data acquisition methods and protocols, easy access and visualisation of data already available.
- **Public Authorities**, and **CS initiatives** alike, should consider moving beyond one-directional data provisions, for example, by entering into dialogues why and how certain contributions could (or could not) be used. Such dialogues should also be considered as an opportunity to address the actual thematic area under consideration.
- **Public Authorities**, and **CS initiatives** alike, should acknowledge existing procedural barriers, i.e. understand the need for a mutual learning progress in which new skills have to be acquired and mistakes will be made.
- **Intermediaries** (third-party actions) should provide user friendly tools (such as data bases for integrating CS data with the current data holdings of public authorities), training and capacity building for both CS initiatives and public authorities, and provide the required coordination capacities.
- Whichever path is taken to make CS data used by public administration, the participants should constantly keep in mind that they will only succeed if the activity is worthwhile and of **mutual benefit for all participants**.

**Consolidated findings from Group 2.5:** *How to enable interoperability (given different jurisdictions, data availability across environmental domains, culture, and geographic scale), considering that interoperability has technical, structural, organisational and legal dimensions?*

- First of all it is necessary to understand **what enables interoperability**. Semantics are a key issue that needs to be well addressed. Established terminology of different communities (and cultures) has to be preserved, while enabling translations between them so that they can understand each other.
- To understand what needs to be made interoperable, we have to judge the benefits and drawbacks of an interoperable solution based on shared values.
- **Equipment and data platforms** are needed in order to implement common or interoperable measurement methods of environmental phenomena.
- Workable solutions are needed in order to **ensure legal** procedures (who is allowed to access certain knowledge under which conditions, per country and across the EU)
- **Physical access** (can the knowledge be accessed anytime from anywhere, or are there physical restrictions in place?) should be ensured at the different scales.

- **Standardise**, as far as possible, data models, data sharing principles, and quality standards. At least standards to describe the quality of Citizen Science products need to be put into place so that "fitness for purpose" can be assessed.
- Interoperability between the different stakeholders that are involved in Citizen Science could be improved by **increasing the value of volunteering**.
- There is a clear need to **increase research to understand behavioural change and cultural dependencies thereof**. How can we reach interoperability while still benefitting from the cultural diversity in Europe?
- We should look to see whether we can **learn from the use of Citizen Science in the context of some EU environmental legislation** (such as the Water Framework Directive, and the Birds and Habitats Directives), and exploit the opportunity of **networking** provided by COST Actions.

**Consolidated findings from Group 2.6:** *Which role might Artificial Intelligence and Earth Observation play to make CS more relevant for environmental monitoring and reporting?*

- For CS contribution to be relevant and useful for environmental monitoring and reporting in the environmental domain and/or policy making in general, **robust data fusion** (e.g. reliable aggregation and harmonisation of very different datasets across space, time, theme...) needs to be applied. This implies the **need for quantified uncertainty on CS data, and statistical** (possibly Bayesian) **frameworks for data management**.
- Just as, in the environmental domain, Earth Observation can be used to **target or stratify more expensive ground surveys**, AI can be applied to large datasets of observations to filter/prioritise those which need extra human effort (for correction, validation etc.), and to **automatically identify candidate labels** (e.g. for images).
- The main challenges encountered when addressing the above, are the necessary **computing power**, time, and expertise, but also the availability of **adequate libraries of training material for AI algorithms**. AI / machine learning tools require plentiful, representative and high quality training data, and to facilitate this, we must encourage the contribution of labelled images and shared ground truth samples to open repositories, such as ImageNet and others. The challenge of opening up such data is longstanding - the obstacles are cultural, legal and commercial, not technical. It may be that funding bodies can best help to push data mobilisation by making grant funding conditional on such contribution.
- In order to implement the desired approaches, **dedicated tools for dynamic AI/EO (i.e. services for interpreting data) should be integrated in CS apps**. The challenge is for a lightweight app, often used in the field with limited bandwidth, to access powerful AI functionality via a web service, in a timely fashion which allows the activity to remain interactive and engaging. **The development of such tools could be stimulated/promoted by a ESA/JRC hackathon**.
- In order to bring EO closer to citizens, **useful modelled predictions** (e.g. air quality) could be offered as a concrete example of what CS can do for them, and to **verify whether the data provided are affecting them**. In this respect, EOCS could identify and promote useful data assimilation tools and platforms.
- We could bring the above proposals to the attention of GEO CA on CS and Earth Challenge 2020.

## **Annex 4. Summary of feedback received from participants**

**Feedback Forms collected = 21 (out of 45 participants)**

### **Answers from participants**

1. Content covered during the presentation?
  - 17 Very good, 4 Excellent, rest: Good
2. Relevance of content with respect to you requirement?
  - Mostly Good or Excellent, 1 Fair
3. Usefulness of activities conducted during the WS?
  - Mostly Good or Excellent, 1 Fair
4. How satisfied were you with networking opportunities?
  - Mostly Very Good, 6 Excellent
5. How satisfied were you with the duration of the WS?
  - Mostly Very Good, 3 Excellent
6. Overall experience at workshop?
  - Mostly Very Good
7. What did you gain most from this WS?
  - Exposure to CS different stakeholders
  - Increased knowledge/overview on CS/state of the art at EU level/knowledge sharing
  - Increased experience and awareness on CS benefits/data quality and validation/how to involve more Citizens Scientists
  - Better understanding of EU networks and policy/monitoring processes
  - Real life insights from key stakeholders/EPAS experience is inspiring
  - Networking with excellent experts from different countries
  - Different/broader perspective of issues around CS
  - The Skeleton of the Guidelines for Environmental Monitoring and reporting looks promising
  - "Trust" is a critical and recurring issue
8. Would you do anything different to make this WS more effective?
  - More specific issues to be addressed
  - Longer duration, day one was not too relevant to me and too focused on introduction
  - Overlap with IAS was sub-optimal (not enough space in the room)
  - Keep back-to back WS separate or integrate them from start
  - Easier access to venue of the event (closer to airport)
9. Do you have any additional recommendation to improve future WS? Kindly enlist them here
  - Present more good practices/two minutes slot

- More examples of challenges to policy up-take
  - Link to country context
  - Invite more "critical" experts (e.g. people against CS practices)
  - Invite more scientists and NGOs as they are key players
  - Provide access to presentations during the WS
  - Allow rotation around group works
  - Extend and optimise timing for presentations, discussions, group works,
  - Broader expertise amongst participants (no example of type though)
  - Networking game e.g. "find your partner" to increase communication amongst the participants
  - Organise dinner to increase networking
  - Interactive on-line participation
  - More WS of this kind
10. Would you like to attend similar WS in the future and recommend it to you colleagues?
- 100% YES

#### **OTHER COMMENTS**

- Good combination between short/succinct presentations and group work/discussions
  - Very constructive atmosphere
- Congratulations for the overall organization, including logistics (travel, accommodation, and transport).

#### **ANALYSIS AND CONCLUSIONS**

- The WS was very well perceived with respect to all workshop dimensions, namely: content, relevance, usefulness of activities, networking opportunities, timing and experience.
- Participants gained mostly in terms of understanding, awareness, knowledge sharing, issues insights, exposure and networking. In this respect our objective to provide a common ground with mutual benefits was fully achieved.
- Some logistical and time management reconsideration would have made the event even more effective, namely: back to back events kept separated, time optimisation around presentations, discussions and group work (much appreciated), easier access to venue (closer to airport). Considering the features that characterised the event in terms of overlap with the IAS WS, and time constraints, these comments are fair.

**The Recommendations** to improve future WS were constructive and creative, and related to three main dimensions namely: **Content** (focus on concrete crucial issues, link to country context, bring in "critical" views, more examples of challenges to policy up-take), **Participants** (broader expertise – Scientists and Citizens Scientists, International Organisations, NGOs, and national policy makers), **Overall organization** (longer time to presentation, discussion group work, access to presentations during the WS, rotation of expert groups, networking activities, interactive on-line participation and easier access to venue).

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