Brussels, 12 February 2016

COST 013/16

**DECISION**

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Subject: **Memorandum of Understanding for the implementation of the COST Action "Citizen Science to promote creativity, scientific literacy, and innovation throughout Europe" (CS-EU) CA15212**

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The COST Member Countries and/or the COST Cooperating State will find attached the Memorandum of Understanding for the COST Action Citizen Science to promote creativity, scientific literacy, and innovation throughout Europe approved by the Committee of Senior Officials through written procedure on 12 February 2016.

**MEMORANDUM OF UNDERSTANDING**

For the implementation of a COST Action designated as

**COST Action CA15212**
**CITIZEN SCIENCE TO PROMOTE CREATIVITY, SCIENTIFIC LITERACY, AND INNOVATION THROUGHOUT EUROPE (CS-EU)**

The COST Member Countries and/or the COST Cooperating State, accepting the present Memorandum of Understanding (MoU) wish to undertake joint activities of mutual interest and declare their common intention to participate in the COST Action (the Action), referred to above and described in the Technical Annex of this MoU.

The Action will be carried out in accordance with the set of COST Implementation Rules approved by the Committee of Senior Officials (CSO), or any new document amending or replacing them:

a. "Rules for Participation in and Implementation of COST Activities" (COST 132/14);
b. "COST Action Proposal Submission, Evaluation, Selection and Approval" (COST 133/14);
c. "COST Action Management, Monitoring and Final Assessment" (COST 134/14);
d. "COST International Cooperation and Specific Organisations Participation" (COST 135/14).

The main aim and objective of the Action is to bundle capacities across Europe to investigate and extend the impact of the scientific, educational, policy, and civic outcomes of citizen science in order to gauge the potential of citizen science as enabler of social innovation and socio-ecological transition. This will be achieved through the specific objectives detailed in the Technical Annex.

The economic dimension of the activities carried out under the Action has been estimated, on the basis of information available during the planning of the Action, at EUR 100 million in 2015.

The MoU will enter into force once at least five (5) COST Member Countries and/or COST Cooperating State have accepted it, and the corresponding Management Committee Members have been appointed, as described in the CSO Decision COST 134/14.

The COST Action will start from the date of the first Management Committee meeting and shall be implemented for a period of four (4) years, unless an extension is approved by the CSO following the procedure described in the CSO Decision COST 134/14.



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## OVERVIEW

**Summary**
We are witnessing a remarkable growth of citizen science (CS), that is, the participation of people from all walks of life in scientific research. The main aim of this Action is 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 NGOs), to gauge the potential of citizen science as enabler of social innovation and socio-ecological transition. The Action will explore the potential transformative power of citizen science for smart, inclusive, and sustainable ends, and will provide frameworks for the exploitation of the potential of European citizens for science and innovation. The relevance and timeliness of the Action derive from the recent explosion of activity around citizen science, as ordinary people and researchers begin to understand the power of technological devices which allow them to record the environment around them and share and collectively interpret data and knowledge to advance science and society.

Given the trans-disciplinarity of citizen science, the Action will benefit from the different contributions and perspectives from a range of disciplines and research cultures. As the latter rarely overlap and engage directly, the Action provides an ideal means for knowledge sharing and focused development on the topic by enabling better integration of separate national activities at a European and international scale.

| **Areas of Expertise Relevant for the Action** | **Keywords** |
|---|---|
| ● Biological sciences: Conservation biology, ecology, genetics<br>● Social and economic geography: Social and industrial ecology<br>● Other engineering and technologies: Sustainability for other engineering and technologies<br>● Sociology: Sociology of science<br>● Educational sciences: Education: training, pedagogy, didactics | ● citizen science<br>● capacity building<br>● sustainable development<br>● participation<br>● social and technological innovation |

**Specific Objectives**
To achieve the main objective described in this MoU, the following specific objectives shall be accomplished:

Research Coordination
● Review the current landscape of CS projects in different areas and deriving from different communities (e.g., science, cyberscience, Do-It-Yourself). By clarifying the state-of-the-art, this activity will highlight strengths/opportunities of employing CS data and other contributions, in addition to limitations/areas that need development for future research activity.
● Identify and enhance good practices that can be applied to CS projects in different areas.
● Provide outcome assessment of CS projects for evidence-based public policy action geared towards tackling societal problems.
● Share experiences and research challenges in using CS in teaching in formal education and in community-based learning.
● Explore ways for integrating data and knowledge collated through CS initiatives and suggest mechanisms for standardization, interoperability, and quality control.
● Draw implications of CS outcomes for the stakeholders from all sectors concerned, including policy makers, social innovators, citizens, cultural organizations, researchers, and charities and non-governmental organizations (NGOs).

Capacity Building

- Include experts from COST Member Countries and International Partner Countries to create a solid global network of experts.
- Encourage engagement and mobility of Early-Career European researchers from a variety of disciplinary areas to foster collaboration and/or to learn new methods not available at their institutions.
- Collaborate with the international community in CS.
- Stimulate knowledge-sharing and policy-learning across national boundaries and among researchers, educators, policy-makers, NGOs, and civil society.



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# 1. S&T EXCELLENCE

## 1.1. Challenge

### 1.1.1. Description of the Challenge (Main Aim)

*The main aim of this Action will be 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.*

We are witnessing a remarkable growth of citizen science (CS), that is, the participation of people from all walks of life in scientific research. From 2007 to 2014, over a million people participated in the Zooniverse project. In the early months of 2014, a team of climate researchers at Oxford University, who wanted to suggest the degree to which recent floods could be attributed to climate change, were able to run over 33,000 models using the unused computing resources of over 60,000 volunteers (ClimatePrediction.net).
Despite the clear upsurge of interest in CS and the growing public involvement, the significant scientific, learning, and civic outcomes of CS are not yet sufficiently recognized even by scientists, as shown in different studies tracking the origin of data and how they are cited. The results showed that citizen scientists often contribute significantly to the body of scientific facts without being acknowledged. While different degrees of recognition by different bodies (e.g., policy makers and scientists) exist for different purposes, also the potential of CS to contribute to sustainable lifestyles is not fully understood or engaged with.
The Action will explore the potential transformative power of CS for smart, inclusive, and sustainable ends, and will provide frameworks for the exploitation of the potential of European citizens for science and innovation. By doing so, the Action will contribute to addressing the specific objective 'inclusive, innovative and secure societies' set out in the Regulation establishing Horizon 2020, notably by deepening the relationship between science and society and favoring an informed engagement of citizens in research and innovation. In relation to this specific objective, the Action will pay particular attention to a better understanding of citizen scientists, in order to ensure CS does not replicate patterns of participation in formal science education, and to ensure promotion of gender equality and the gender dimension in research and innovation.
Achieving the main aim of the Action requires an active network with opportunities for face-to-face and online dialogue. The research coordination and capacity building opportunities offered by a COST Action allow the expertise that exists in disparate European groups to be brought together to focus on the main outcomes of CS and the main issues to be addressed to enhance impact, scalability, and potential for social innovation. Together the Network of Proposers has the ability to establish the state-of-the-art and set out how to develop future activity constructively, through building an enhanced and coordinated understanding and extending impact of CS outcomes. The required expertise lies across traditional disciplinary boundaries, spanning the social sciences, natural sciences, and computer science. By bringing the Network of Proposers together with a clear focus on mapping the outcomes of CS projects, the Action has the potential to achieve the expected results and play a role in the delivery of the Europe 2020 strategy towards sustainable lifestyle and socio-ecological transition. Specifically, the Action has the potential to stimulate the establishment and support of a social innovation 'community of practice' of researchers, social innovators, citizens, and policy makers, by gathering and disseminating evidence of CS outcomes and developing creative ways to link these outcomes to social innovation.

### 1.1.2. Relevance and timeliness

The relevance and timeliness of the Action derive from the recent explosion of activity around CS, as ordinary people, researchers, and non-governmental organizations (NGOs) begin to understand the power of Information and Communication Technologies (ICT) with the proliferation of tablets, smartphones, and wearable devices, which allow them to record the environment around them and share and collectively interpret data and knowledge to advance science and society. The trend towards a growing number of citizens, often with a particular interest and/or stake in the outcome of the research, getting involved in collaboration with scientists has been acknowledged as a way of 'opening up the research process' by the European Commission in the document 'Science 2.0: Science in Transition'. This involvement can promote a more democratic form of citizen participation in policy making about critical societal areas, such as climate change, environment protection, sustainable lifestyles and personalized medicine, just to name a few. This active involvement of citizens in both the steering of science and the provision of data and knowledge for advancing research reflects a trend towards the societal embedding of science and the orientation of scientific research agendas towards addressing societal challenges. Furthermore, the EU has recognized that citizen involvement in the scientific enterprise contributes to furthering interactive processes of knowledge utilization and knowledge valorization and to making science more relevant to societal needs.

Despite this fast moving agenda, which is now stimulating activities across the globe, there are only few examples of policy makers grasping the opportunity to leverage the large data sets from citizens to understand, for example, if the EU environmental or climate change policies are working. There is a reluctance to use or accept citizen data, as it were not as good as professionally gathered data, or as participants may have suspect motives that can bias research (see, for example, the editorial on the rise of the citizen scientist published in *Nature* on August 18, 2015). There are few examples where CS is being used to answer policy questions, but almost no examples at the European level showing how data from CS have been used in data programmes to monitor the effectiveness of EU Directives. The European Environment Agency has been in the vanguard in seeking to encourage such action and has supported the emergence of coordinated CS programmes such as the Marine Litter Watch and Noise Watch, but overall we still have too few examples to prove the value of CS at this strategic level. Thus, the Action will provide evidence to stakeholders, including policy makers, universities and research centers, and citizens to increase recognition that not only data and other information generated through CS projects contribute to scientific knowledge, but civic outcomes at a time when the EU is attempting to manage significant transitions in relation to competitiveness, education, environment, and employment.

However, it should be noted that CS works better for some purposes/problems than others, and a better understanding of these contingencies would be very valuable for research as well as social innovation and policy-making. As such, CS will not simply diffuse, but it is necessary to understand when and how its applicability can be broadened.

## 1.2. Specific Objectives

### 1.2.1. Research Coordination Objectives

The aim of the Action will be to jointly investigate and extend the impact of the scientific, educational, policy, and civic outcomes of CS. Therefore, the Action seeks to enhance the recognition and value of the different types of CS contributions. In order to respond to its challenge, the Action will work to achieve the following Research Coordination Objectives:

1. Review the current landscape of CS projects in different areas and deriving from different communities (e.g., science, cyberscience, Do-It-Yourself). By clarifying the state-of-the-art, this activity will highlight strengths/opportunities of employing CS data and other contributions, in addition to limitations/areas that need development for future research activity.
2. Identify and enhance good practices that can be applied to CS projects in different areas.

3. Provide outcome assessment of CS projects for evidence-based public policy action geared towards tackling societal problems.
4. Share experiences and research challenges in using CS in teaching in formal education and in community-based learning.
5. Explore ways for integrating data and knowledge collated through CS initiatives and suggest mechanisms for standardization, interoperability, and quality control.
6. Draw implications of CS outcomes for the stakeholders from all sectors concerned, including policy makers, social innovators, citizens, cultural organizations, researchers, and charities and non-governmental organizations (NGOs).

Arising from these activities, a series of outcomes are anticipated with key deliverables including:

- State-of-the-art summary of the outcomes of CS - focused on data quality, dissemination and current utility for science, education, policy-making, and social innovation. This summary will also provide hard evidence of the ways in which CS initiatives support policies and decision makers at the local, national and European level to reach environmental, cultural, and economic sustainability targets. This will form the basis of some major review papers in peer-reviewed journals.
- Survey of methods to address data quality issues - focused on methodology, education and training materials, evaluation criteria, summarized in a journal and working papers.
- Recommendations on how to encourage valuable collection of data from citizens, summarized in popular/professional articles and academic papers.
- Publication and standardization of an ontology to describe CS projects.
- Documents outlining the good practices in conducting and evaluating CS, disseminated in a variety of ways, including Massive Open Online Courses (MOOCs), targeted to specific audiences.
- An enriched community in which the role of research centers, museums and cultural institutions in leveraging CS programs is recognized and appreciated.

Expansion of the community engaged constructively in CS, from individual members of the public to science communicators, museum curators, and academic researchers, with an emphasis on supporting the advancement of Early-Career Investigators (ECIs) and their connections to other researchers in the field.

### 1.2.2. Capacity-building Objectives

The Action will strive to link together existing expertise operating in relevant areas in Europe. Engagement in CS varies significantly across the European Research area, with some countries with strong levels of activity and networking and some with much lower levels. Therefore the aim of the Action is to share disparate and disconnected national experiences and increase the capacity, especially in those countries in the network that need to develop new activities. In order to respond to its challenge, the Action will work to achieve the following Capacity-building Objectives:

1. Include experts from COST Member Countries and International Partner Countries to create a solid global network of experts.
2. Encourage engagement and mobility of Early-Career European researchers from a variety of disciplinary areas to foster collaboration and/or to learn new methods not available at their institutions.
3. Collaborate with the international community in CS.
4. Stimulate knowledge-sharing and policy-learning across national boundaries and among researchers, educators, policy-makers, NGOs, and civil society.

Arising from these activities, a series of outcomes are anticipated with key deliverables including:



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- Develop a common research agenda and create the conditions for participating in research and development projects, e.g., Horizon 2020.
- Run eight Short-Term Scientific Missions (STSMs) over the four years to broaden the experience of Early-Career Investigators (ECIs) and promote a European and eventually worldwide network on CS.
- Prepare academic Training Schools (TSs) for ECIs and more established Action members to provide opportunities for mentoring and knowledge sharing between the two groups. Five TSs will be provided. The topics of TSs will be connected to the activities of Working Groups (for example, a TS will be devoted to methods to address data quality issues).

Organize seminars and workshops to stimulate ongoing debates on the impact and value of CS.

## 1.3. Progress beyond the state-of-the-art and Innovation Potential

### 1.3.1. Description of the state-of-the-art

**The past decade has seen a rapid increase in the number of CS projects and their scale, due to technological and societal changes.** Within the general populations, there is a growing percentage of people with suitable education and understanding of scientific concepts, as well as access to the Internet and mobile devices with computational and environmental sensing functions. Today citizen scientists can contribute to science from home, for example, installing sensors (passive sensing), or can participate in outdoor activities, recording environmental or ecological observations, carrying out sensing activities using smartphones or other devices (participatory sensing), or purposeful community activities aimed at addressing a common issue of concern (community or civic science). Citizen scientists can collect data simultaneously at continental, national, or state-wide scales, but may also collect data on an ongoing basis over large areas. The value of data generated by citizens can amount to millions of Euros. For example, a statewide CS ornithological study provided more than 200,000 hours of data collection that was valued at over a million dollars, even based on minimum wage. However, the role of the citizen scientist is often seen as limited to collect data, while scientists remain legitimated to perform all the other activities in the research process, such as setting problems and methods. Innovative projects show there is a variety of roles citizen scientists can play in different activities, ranging from 'participatory experiments' and 'collective intelligence' to 'volunteer computing'.

**Citizen science is open to several definitions and contains more than one strand.** For this reason, CS research is rather fragmented. One meaning of CS encompasses a trend that has gained momentum in recent years and can be seen as projects taking the form of large-scale research enterprises, predominantly in the natural sciences. In these projects, volunteers are generally limited to collecting data for purposes identified by researchers. Partly overshadowed by the contemporary 'hype' generated by the first type of CS presented above, another meaning of the concept, which concerns 'scientific citizenship', gains momentum as a deliberative and democratic phenomenon. In this version of CS, professional researchers take the role of assisting the needs and concerns of citizens by drawing on knowledge developed by citizens themselves.

**The growth in scale, scope, and significance of CS is starting to receive attention by policy makers and other stakeholders** at local, national, and international levels, as well as government officials, scientists in government, industry and academia, as well as those working in non-governmental organizations. Policy makers increasingly understand the importance of CS for policy formulation and implementation and for their educational potential, especially in science, technology, engineering and mathematics (a good example is the White House Science Fair and their campaign called 'Educate to Innovate' to inspire and prepare more girls and boys – especially those from underrepresented groups – to excel in STEM fields). By stakeholders, CS has for example been tapped into for developing innovative educational approaches, such as 'citizen inquiry', where

members of the public are supported in developing open inquiry-led science investigations in collaboration with science experts.

### 1.3.2. Progress beyond the state-of-the-art

This Action will provide significant progression beyond the state-of-the-art, as no existing network can address the following issues in a coordinated way:

- Understanding the impact of CS in relation to societal challenges and policy.
- Widening and qualifying the base of participation in CS.
- Extending the role of contributors to CS.

**Extending the impact of CS in relation to societal challenges and policy by building the evidence base.** Although there is a variety of CS project the overall impact on social innovation is rather claimed than proven. Understanding the pathways how CS supports a responsible citizenship facing environmental, social, and cultural challenges successfully will increase societal resilience. For example, by 2020 the EU estimates that nearly 80% of our citizens will live in urban areas. Urbanization opportunities and environmental and societal and economic challenges are closely connected. Many cities struggle to cope with social, economic and environmental problems resulting from pressures such as overcrowding or decline in residents, social inequity, pollution and traffic. Civil society is rich with discussions focusing on needs – health, sustainability, poverty alleviation, new sources of energy, etc. – that should be taken into account. It is therefore crucial that CS programmes have the ability to reach the larger and growing populations of citizens that live in and experience the environmental problems that are emerging in cities worldwide.

**Widening the base of participation in CS by developing methods and increasing visibility**. Despite the growth in scope and scale of CS in terms of number of participants, and the awareness of CS among policy makers, especially those working in the environmental sector, there is a need to extend participation in CS and increase its impact. The best estimate of the number of Europeans involved in CS is not more than 2 million. Considering that at least 25% of EU population hold an advanced degree and can potentially participate in CS, probably at least more easily then individuals without an advanced formal education, it should be possible to increase this number significantly. However, to ensure CS does not replicate patterns of participation in formal science education, new methodologies are needed to reach and engage members of under-represented groups such as women, youth, elderly, disadvantaged ethnic and linguistic groups. Special attention should be paid to these groups that, mostly unintentionally, are excluded from CS activities. Well-educated white men aged 20-65 from well-to-do socioeconomic backgrounds are overrepresented in CS. At the European Research Area level, CS is concentrated in some countries, especially northern Europe, where people have access to the necessary equipment. It is necessary to take these imbalances into account and address barriers to engagement, by enhancing existing good practices and building response capabilities.

**Extending the role of contributors to CS by methodology development and quality assurance**. There is a need to extend participation of citizen scientists beyond their role as data collectors. For this purpose it is necessary to develop methodologies for more active and deeper citizen engagement, in order to increase the capacity of specific projects to generate 'scientific citizenship', that is, the potential of such projects to generate further questions, projects, actions and policy impacts. Furthermore, appreciation of the quality data yielded by citizen scientists needs to be built, both at the level of the project, as well as end-users of the information. Appropriate guidelines and information should be developed to facilitate the use and interpretation of CS data.

### 1.3.3. Innovation in tackling the challenge

The Action rises to the challenge of making CS better recognized. It is innovative in linking the expertise existing in Europe to investigate and enhance the scientific, educational, policy, and civic



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outcomes of CS in the following ways: Regarding specific outcomes, the Action will generate an improved and common understanding of CS linking hitherto fragmented definitions and research approaches. It will also collate evidence and create new concepts of the impact of CS in the above mentioned areas. Furthermore, good practices and innovative examples of using CS to address key science and societal challenges will be collected and made visible across Europe. The Action will also produce a series of new products in the form of maps and guidelines that inform relevant stakeholder groups on CS and how to use it. In order to address technological fragmentation and promote interoperability, data standards will be established in the form of a CS ontology.
On the more general level, the Action will give a degree of coordination to existing activities, seek to extend them across the EU and straddle several disciplines, (e.g., education, policy studies, environmental science, geography, computer science, art and humanities). Another innovative aspect is the interest in civic outcomes with which the Action will contribute to strengthen a sense of 'public value' of science, to run alongside its economic and intrinsic values.

## 1.4. Added value of networking

### 1.4.1. In relation to the Challenge

The core focus of the Action is to provide evidence to support recognition of the scientific, educational, policy, and civic outcomes of CS, to gauge the potential of CS as enabler of social innovation and socio-ecological transition. In doing so, the Action will also build capacity, notably in enhancing the community of young researchers, and facilitate mobility and knowledge exchange within Europe for broader scientific and social benefit. Additionally, an added value is the contribution to a more active role for citizens in scientific and policy processes. Given the transdisciplinarity nature of CS, the Action will benefit from the contributions that can be offered from different disciplines and research cultures. As the latter rarely overlap and engage directly, the Action provides an ideal means for knowledge sharing and focused development on the topic by enabling better integration of separate activity at national scales. For example, the opportunity to engage social scientists and educators, which are so far under-represented, in the Action will offer them exposure to current research results and state-of-the-art methods and good practices. Furthermore, the involvement of stakeholders, e.g. environmental agencies, provides unique opportunities for mutual learning across the usual gap between researchers and practitioners and will contribute to the long-term application of CS.

### 1.4.2. In relation to existing efforts at European and/or international level

The Action is highly innovative in the topic as there are no systematic activities specifically aimed at integrating research on CS at a broader level. The Action will contribute to preparatory research and development projects in the field of public engagement, sustainability and social innovation, with the aim to use networks to connect citizens and ideas for social innovation. The Action will also strive to develop collaborative relationships with existing relevant networks and research projects already involving the Proposers and funded through EU and national grants. Since CS is also established in the USA, Australia and New Zealand, scholars from these countries will be included to ensure that this Action is a central player in the global debate. It offers also the potential to cooperate to bid for research funded in non-European countries for parallel research projects. International experts will be invited to present during WG's meetings, STSMs and training schools.

# 2. IMPACT

## 2.1. Expected Impact

### 2.1.1. Short-term and long-term scientific, technological, and/or socioeconomic impacts



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**Scientific and technological impact:** The implementation of the Action is consonant with the vision for Open (Digital) Science in Horizon 2020, which should enable the 'emergence of new scientific practices, disciplines and paradigms to respond to the new challenges through global distributed collaborations where citizens and society participate as contributors and direct beneficiaries of scientific knowledge' (p. 2). Here as well as in the Responsible Research and Innovation agenda, the involvement of citizens as active participants is envisaged to promote more innovative, ethical, effective research modes where citizens both contribute to the results and shape the research process. Trough improving the understanding of CS and providing guidelines, the Action will contribute to involving individuals and companies in volunteer science and technology research collaborations and crowd-sourcing projects. These volunteer efforts will generate new ideas, technology, and scientific data, as well as increase awareness and capability in science and technology for many people. In addition to the vast innovation potential of CS that the Action will help to explore, the data standards it will generate will facilitate the exchange and valorization of CS data. The greatest long-term scientific impact will be achieved in a twofold way: (a) by improving process and data quality thus improving the trustworthiness of CS and its availability for science and decision-making, and (b) by changing the relation between experts and laypeople in forms of engagement and thus make especially applied research more relevant and suitable. Therefore, the Action will have an indirect impact on the top level targets set out by DG Research and DG Connect, specifically on strengthening a positive attitude towards science (which contributes to raising R&D investment), with the potential of increasing interest and participation in scientific careers of youth and women.
**Socioeconomic and policy impact**: The Action addresses the aim to move towards socio-ecological transitions, social innovation, and sustainability by providing an improved knowledge base and decision support tools to stakeholders (researchers, policy makers, etc.) at the European and national levels in order to facilitate the integration of CS into other policies and sectors, such as environment, climate change, and cultural preservations. The implementation of the Action will also have an indirect socio-economic impact through making visible the value-added created by CS projects. For example, citizen monitors can document the consequences to local community livelihoods and environments from existing industrial and energy practices. In this respect, citizen scientists are a priceless resources offering 'new paradigms to societies stuck in old ways or trapped, as Western industrial societies are, in wasteful consumption and production habits and obsolete technologies that are proving unsustainable' (Henderson, 1993, p. 237). At the time in which an increasing number of governments and businesses also recognize the need to restructure economic activities into low-carbon and more sustainable forms, citizen scientists contribute to promote niche-oriented civil society activities, such as awareness raising, social pressure and alternative visions, pathways and methodologies, which can constitute pressures for change.

In the longer term, the Action contributes to establish CS as recognized methodology for science, technology and mathematics education and thus also addresses the fundaments of future wellbeing and economic competitiveness in Europe. Another long-term impact will be achieved by establishing links with high-level decision makers who understand the value and can champion the cause of CS beyond the Action's end.

## 2.2. Measures to Maximise Impact

### 2.2.1. Plan for involving the most relevant stakeholders

The Action will carry out a vast program of dissemination and outreach activities in order to actively engage stakeholders. Relevant groups of stakeholders will include: (a) policy makers at several levels, Environmental Protection Agencies (EPAs) and other implementation agencies; (b) (organized) citizens; (c) cultural organizations doing CS, such as museums and science centers; (d) researchers from universities and other scientific institutions – e.g., academies – (interested in) working with CS; (e) charities and NGOs; (f) social entrepreneurs, and (g) research agencies and funding bodies at the national and international level.

In order to reach the most relevant stakeholders, the Management Committee (MC) will elaborate a stakeholder engagement strategy and update it each year. Particular attention will be paid to ensuring inclusiveness through balanced involvement of stakeholders from COST member countries as well as across stakeholder groups, The stakeholder engagement strategy will also specify measures to identify potential Action participants in countries where CS is not yet well-known and address COST Inclusiveness Target Countries (ITCs).

### 2.2.2. Dissemination and/or Exploitation Plan

At the outset of the Action, a dissemination plan will be elaborated according to the COST guidelines and revised regularly. The core outcomes of the Action are defined in sections 1.2.1 and 1.2.2. The outcomes will be targeted at different groups as appropriate to their needs and interests. To reach the groups identified in section 2.2.1., the main materials to be disseminated will be:
**Policy-makers, Environmental Protection Agencies (EPAs) and other implementation agencies** - the focus will be on providing policy reports about key conclusions of the Action and policy recommendations, as well as on organizing events, which will offer examples of good practices, major pilot studies and their impact on society.
**Citizens and NGOs** - the focus will be on providing short articles in popular scientific and popular literature (e.g., popular magazines and professional magazines) and via social digital networks presenting summaries of the outcomes of CS, recommendations on how to encourage valuable collections of data, and good practices in doing CS. Short articles will also be disseminated via social media to elicit feedback from the public, including through existing CS projects.
**Cultural organizations involving CS** - this group will be most interested in the state-of-the-art review and the good practice documentation as the main material, with the academic papers as supplementary information and the Action's final output as a key reference. Articles in professional magazines will also help disseminate the Action's outputs to the professional communities involved in CS. This group will also be the target audience for training workshops and seminars linked to WG meetings.
**Researchers from universities and other scientific institutions** - this group will be the target audience for the main review journal papers, survey of methods to address data quality issues, best and good practice documentation. Articles will be directed to the main high-impact peer-reviewed international research journals. To ensure broad dissemination, a substantial proportion of the journal publications from the Action will be in open-access form. In addition, interactive online formats are used such as webinars, MOOCs, digital stakeholder roundtables, or YouTube tutorials. It is likely that the activities of some WGs will be amenable to producing journal special issues on Action related topics and this will be encouraged, especially to promote the careers of early stage researchers. The final outcome of the Action will be its final proceedings, which will take the form of a digital and open access edited book. This book will provide a reference source that will be the legacy of the Action's activity and the basis for future work spurring grant applications at the national and European level (e.g., Horizon 2020). This group will also be the target audience for TSs and STSMs, which will involve especially ECIs.
**Social entrepreneurs, charities and NGOs -** will be invited to participate in several activities associated with this Action to enhance the practical application and policy impacts, in addition to its scientific value. For example, two stakeholder consultations will be organized during this Action to involve these target groups.
**Research agencies and funding bodies -** policy briefs and personal interaction formats such as stakeholder round tables will be provided with a focus on the added value of CS as well as methodologies of how to design CS projects, ensure data and process quality, and evaluate impact.

In addition to the means of dissemination focusing on specific interest groups listed above, other communication techniques will be used for communicating and disseminating the Action's activities also inside the network, including:

- The Action's website. This site will have sections devoted to activities of the different WGs, will be updated on a regular basis, and will be linked to associated social media (e.g., Facebook and Twitter). Summaries of key findings and good practice documentation will also be published on the website.
- Outreach activities, such as exhibitions and conferences targeting the different disciplinary communities involved in the Action. ECIs will be encouraged to give presentations to major conferences to support their professional development.
- Organization of Action events on a side of other events like conferences or workshops.
- Inclusion of Action outcomes in courses run by the Universities involved and beyond.
- A newsletter announcing progress of the Action as well as mobilizing the community to participate in the different activities

As the Action develops, other stakeholders may be involved, perhaps though formally joining the Action. The MC will review and change as appropriate the Action's dissemination plan to reflect any agreed changes.

## 2.3. Potential for Innovation versus Risk Level

### 2.3.1. Potential for scientific, technological and/or socioeconomic innovation breakthroughs

The Action will develop a 'community of practice' including scientific and reflective organisations, NGOs, policy actors such as EPAs, and SMEs that shares expertise, knowledge, lesson learned, and best practices. This community will be able to connect to the relevant stakeholders and develop collaboration, share research results, and other resources. The knowledge developed within the Action has the potential to respond to outstanding questions on quality and utility of CS outcomes, and to find solutions and pathways that makes CS more trustworthy and actionable for decision-making. Therefore, the Action has the potential to develop creative ways to address current challenges and improve processes that enable and support social innovation interventions to achieve smart, inclusive, and sustainable ends in crucial societal areas, e.g., health, sustainability, poverty alleviation, and new sources of energy, among the others.
An element of risk and innovation at the same time is represented by the diversity of the Action Proposers who have different experiences, and socio-political and educational systems and cultures in their countries. Next to the intrinsic risks addressed above, risks can also be the economic crisis as well as the increasing demand of public resources needed to relieve the migrant crisis. How far the integrative power of CS approaches can reach is an open question.

# 3. IMPLEMENTATION

## 3.1. Description of the Work Plan

### 3.1.1. Description of Working Groups

The Action will focus on five main areas organized around five Working Groups (WGs). Four WGs will address the settings to which the outcomes of CS projects apply: (1) science; (2) education; (3) policy; and (4) civil society. The fifth WG will be devoted to data standardization and interoperability. The division into these five WGs is made for practical reasons, to increase efficiency and gain in-depth understanding of their respective topics. To ensure cooperation between WGs and address interrelations between the topics they cover, cross-WG synthesis measures in the form of 2 join tasks and deliverables will be taken. Each WG will allocate time for those activities and specific cross-WG exchange slots that allow all Action members to meet will be designated during plenary sessions.



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WGs will present their work during the interim and final meetings, as well as in local and international conferences. The work conducted by these WGs will be displayed on the website and published in scientific and popular and professional venues. Electronic communication (e.g., e-mail and Skype) will be used to facilitate work and communication among the Action participants.
Although the WGs will be flexible and open to include new substantive directions and content, in order to address the research coordination objectives in section 1.2.1., each WG will evaluate the following aspects within its setting: (a) state-of-the-art; (b) good practices; (c) methods to address data quality; and (d) evaluation of impact. To meet the capacity-building objectives in section 1.2.2., the WGs will promote STSMs, training workshops and seminars to further strengthen the links between the WGs and between the Network of Proposers and researchers and practitioners outside the Action.
Membership of the five WGs will be open to allow new memberships and will be monitored annually by the MC with particular regard to gender balance and early stage researchers. Early stage researchers will be encouraged to take on co-ordination roles of WGs to enhance their representation and contribution to the Action. Below is a description of the scope of the five WGs:

**WG1 'Ensure scientific quality of Citizen Science'** will focus on the outcomes of CS projects for scientists. The objective of this WG is to provide a sound understanding of current practices involving the collection, description, and validation of data gathered and analyzed by citizens. Tasks to be undertaken are:
**Task 1:** Undertake a systematic review of methods for data quality and validation and design approaches to CS projects (e.g., selection of volunteers, training requirements, task design).
**Task 2:** Develop a set of good practices to develop and carry out projects that are scientifically sound.
**Deliverable 1:** Systematic review of CS data quality (Task 1).
**Deliverable 2:** Systematic review of CS project design (Task 1).
**Deliverable 3:** Popular/professional articles, academic papers and policy briefs with key recommendations on how to encourage valuable collection of data from citizens (Task 1 and 2).

**WG2 'Develop synergies with education'** will focus on the learning outcomes of CS projects. The objective of this WG is to increase awareness about the possibilities of CS in education, by collating the knowledge of current practices and underscoring the meaning of CS in formal and informal education. Tasks to be undertaken are:
**Task 1:** Undertake a systematic review of the design of CS projects (e.g., educational background of participants, training requirements, task design), and of the practices through which participants have gained knowledge of topic areas.
**Task 2:** Develop conceptual frameworks for training materials to enhance learning in the future development of CS projects.
**Deliverable 1:** Systematic review of synergies between CS and education (Task 1).
**Deliverable 2:** Systematic review on training requirements for citizen scientists (Task 1).
**Deliverable 3:** Concept of training workshops, preferable to be realized as a massive open online course, on using CS for educators (Task 1 and 2).
**Deliverable 4:** Toolkit to evaluate learning via CS projects for educators (Tasks 1 and 2).

**WG3 'Improve society-science-policy interface'** will focus on the outcomes of CS 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 CS by providing evidence and guidance material, so that they can use it as part of policy formation, implementation and evaluation. Tasks to be undertaken are:
**Task 1:** Collate good practices and existing policy guidelines on how to use CS for policy making and implementation.

**Task 2:** Identify and raise awareness of success factors and mechanisms that increase the policy impact of approaches drawing upon CS, taking the integration of citizen-generated data with official data into account.
**Deliverable 1:** Compendium of different science-policy interfaces that have been improved by CS activities (Task 1).
**Deliverable 2:** Scientific paper on mechanisms of how CS improves society-science-policy interfaces (Task 2).
**Deliverable 3:** Policy Brief on CS engagement in different research domains and at different levels of governance in relation to specific societal challenges, including data integration (Task 2).

**WG4 'Enhance the role of CS for civil society'** will focus on the outcomes of CS projects for citizen and social entrepreneurs, paying particular attention to the results of community-led or co-created projects. The objective of this WG is to raise awareness of the results of CS contributions and their implications for developing social innovation interventions. Tasks to be undertaken are:
**Task 1:** Map volunteers' aims and needs with respect to their engagement in projects and derive recommendations for CS project design.
**Task 2:** Review practices of participation in CS involving volunteers.
**Task 3:** Develop a framework of participation based on a review of evaluation methods of the contextual and environmental factors that mediate the effectiveness of different participatory practices.
**Deliverable 1:** Review on participants' requirements for volunteering in CS projects (Task 1)
**Deliverable 2:** Recommendations for CS project designs that address volunteer needs (Task 1).
**Deliverable 3:** Scientific paper systematizing forms of participation in CS (Task 2).
**Deliverable 4:** Paper on CS participation practices with regard to global grand challenges (Task 2).
**Deliverable 5:** Scientific paper to contribute to the understanding of the role of CS for social innovation *(Task 3).*

**WG5 'Improve data standardization and interoperability'** will focus on improving the technical foundations to foster the impact of CS globally. The objective of this WG is to develop metadata-concepts vocabulary and an ontology to support data sharing among CS projects. WG5 will coordinate with activities on data and service interoperability carried out in Europe, the USA and Australia, and will take into account existing standards, namely Open Geospatial Consortium (OGC) standards, ISO/TC 211, W3C standards (semantic sensor network/Linked Data), and existing GEO/GEOSS semantic interoperability.

**Task 1:** Development of a metadata ontology for CS.
**Task 2:** Coordination of efforts with existing networks and groups working on standardization in CS.
**Deliverable 1:** Downloadable version of the ontology code via Action website (Task 1).
**Deliverable 2:** Standardization of the ontology as sensor web enablement profile for CS by OGC (Task 2).

**Cross-WG-Synthesis and overarching** measures will be taken to ensure learning and the creation of an added value of the Action as a whole.
**Task 1:** Cross-working group synthesis communication which will take place within the different activities and especially the bi-annual meetings of the MB.
**Task 2:** Capacity building, which includes the activities STSMs, one training school per Working Group as well as online and digital seminar.
**Task 3:** Internal and external communication including webpage, newsletter, meetings, site events as well as the award for outstanding females and ECIs.
**Deliverable 1:** Scientific article outlining a common concept of CS (Task 1).


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**Deliverable 2:** Roadmap document containing common research agenda for CS to address global grand challenges (Task 1).
**Deliverable 3:** Open access edited book on CS and innovation (Task 1).

### 3.1.2. GANTT Diagram

The total duration of the Action is 4 years. In order to reduce costs, enhance cross-cutting networking opportunities, and increase efficiency, some events will be combined (e.g., WG meetings and MC meetings/Annual Meetings). SC meetings will take place sometimes electronically and sometimes concurrently with MC meetings (Fig. 1).

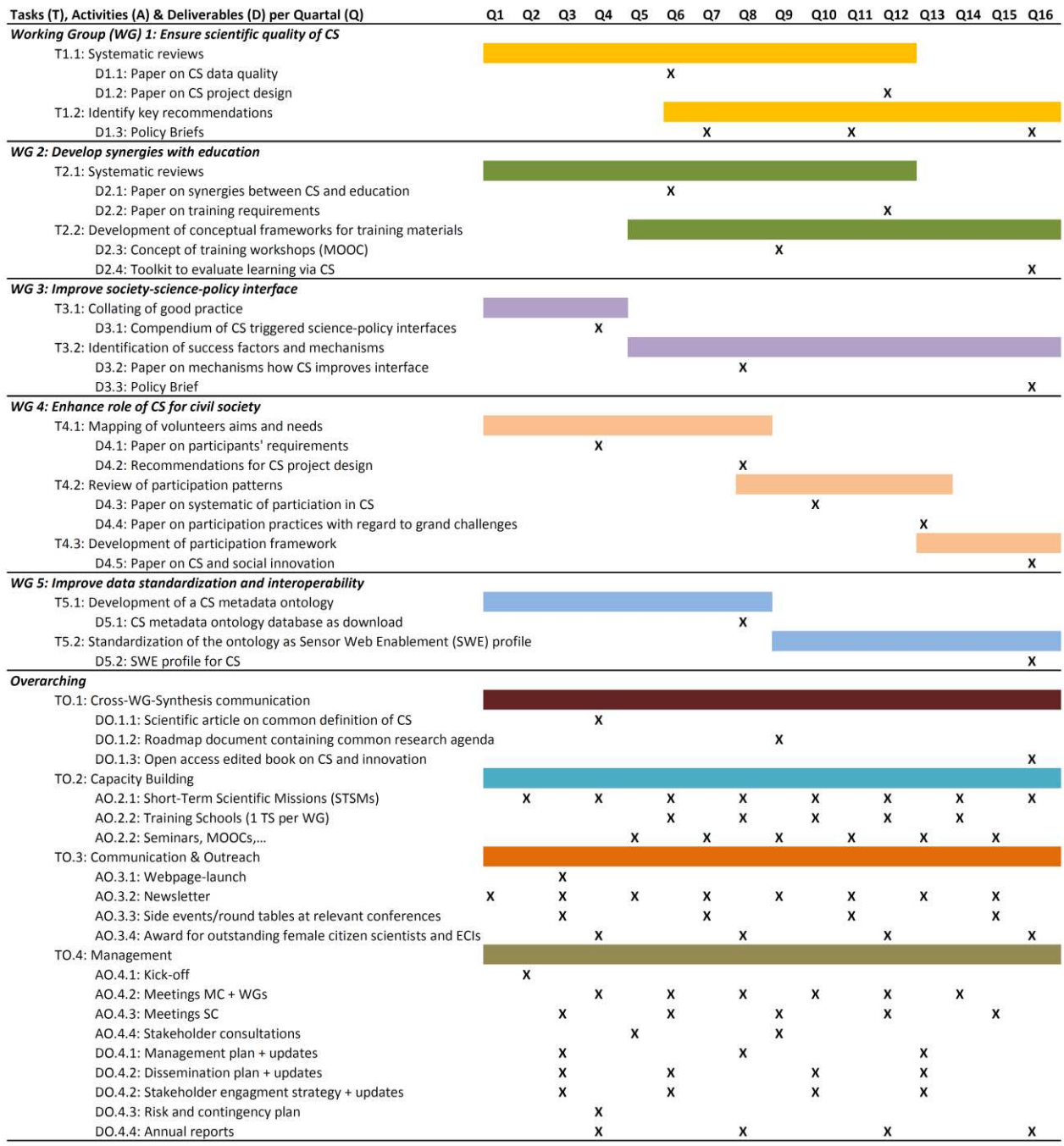


Figure 1: GANTT Chart.



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### 3.1.3. Risk and Contingency Plans

The Chair, the vice-Chair and the Managing Committee (MC) will be responsible for managing risks and taking corrective actions as necessary. They will develop a Risk Assessment and Contingency Plan at the beginning of the Action to minimize possible deviations from the expected results and timeline. While a more complete list of risks will be developed at the Action's inception, an indicative list of risks and proposes risk-mitigation measures is as follows:
*Risk 1. The objectives of the Action are not achieved at the end of the time scheduled*: Regular meetings, taking any necessary corrective actions to meet the plan, pre-checking of results (against the objectives of the Action) and ensuring their internal distribution. Overview by the MC. All the Proposers have a very good track record of delivering all the activities to a high level standard and on time.
*Risk 2. A Proposer decides to leave the Action*: Another Proposer should take over the tasks and responsibilities to lead the Action to success. The MC will look for another Proposer.
*Risk 3. Lack of communication among Proposers*: More frequent interactive communication means, e.g., Skype calls and even face-to-face meetings.
*Risk 4. Schedule and cost limitations*: The MC will monitor the schedule and the work progress tightly. The MC will also monitor costs by planning the Action's activities carefully.
*Risk 5. Delay in submitting deliverables (e.g.: publications)*: Each WG will set a detailed schedule and work-plan to ensure the risk of delay is minimized.
*Risk 6. Low participation in the activities, especially STSMs and TSs, and in particular of women and ECIs:* Specific actions will be targeted to encourage participation of these two groups (e.g., an annual research and outreach award). An STSM and TS coordinator will be appointed.
Risk 7. *Failure to reach the necessary number of stakeholders and not having the promised impact*: A tailored management plan will be elaborated to make use of the Action Members' resources in relevant fields of expertise, as well as to strengthen information and dissemination procedures. Engaging external specialists will be considered.

## 3.2. Management structures and procedures

The Action will be managed in accordance to the 'Rules for Participation in and Implementation of COST Activities'. The MC will include up to two representatives plus the nominated substitutes from each of the participating countries and will supervise and monitor the progress of the Action, coordinate annual reports, supervise budget allocation and assess new applicants. Although no deviation from the stated COST procedures is anticipated and, therefore, the composition of the MC cannot be defined at this stage, named individual members of the MC will hold key roles, namely:

- an early-stage researcher representative to promote the integration of early-career researchers within the Action. This representative will suggest topics for early-stage researcher events (e.g. on writing for journal publication) and will promote social activities;
- an equal opportunities officer to promote gender balance within the Action;
- an 'external view/liaison' representative to monitor related activity, especially outside the European Research Area, and to update the MC on key trends and activities with the aim of enhancing benefit and avoiding duplication. This role holder will be the key link to external groups;
- a dissemination and outreach manager to update the MC on dissemination and outreach activities;
- an STSM and TS coordinator.

The MC will meet every six months. At the kick-off meeting, the MC will set up a **Steering Committee** (SC) and the WGs. The SC will include the Chair, the vice-Chair, and the coordinators of each WG. The SC will responsible for the operational management of the Action and will include the Chair, the vice-Chair, the WG coordinators, the equal opportunities officer, the dissemination and outreach manager, and the STSM and TS coordinator. It is expected that the SC will meet every three months, either in person or through electronic means (e.g., video or tele-conferences) to keep the focus on the Action's objectives and ensure that the main Action activities and schedule of meetings are well planned. These meetings may also be needed to help ensure that the necessary flows of information between the five WGs occur within required timeframes.

The WGs will be organized during the MC kick-off meeting and may be subject to additional changes after the experience of the first working period. Each WG will elect a Chair and a Co-chair to coordinate activities and ensure the exchange of information with the other WGs and with the MC. WGs will present their work during regularly scheduled Action's meetings, as well as at international and local workshops, academic seminars and conferences. WGs will meet at least twice a year and will use electronic communication (e.g., email, Skype) to coordinate and work. Possibly, WG meetings will be scheduled in connection with other events (e.g., international conferences) and taking into account requirements of family-friendly policies.

The MC will monitor progress and achievements of the Action every 6 months. All the WGs will submit short annual reports on their activities to the MC, who will assemble and approve an annual Action progress report mapping the annual activities onto the Action's programme and deliverables, and making observations and recommendations as needed.

The Action will support the active participation of female researchers and ECIs, who will be encouraged to chair, or co-chair if they are highly inexperienced and likely to benefit from mentoring and guidance from senior researchers, WGs, and to lead activities. To further encourage the participation of ECI and the development of a critical mass of female researchers, two STSMs will be organized each year, as well as training activities on relevant topics (e.g., validation of citizen data). Specifically, STSMs will support learning from and interactions with more experienced researchers. Once a year there will be an event devoted to award one female researcher and one ECI.

A **Dissemination Board** (DB) will be responsible for the coordination and implementation of dissemination and outreach activities. A dissemination and outreach manager will be appointed to coordinate this board. In this DB, a subcommittee will be responsible for the development and maintenance of the Action website. The Web site will have both scientific dissemination sections, dedicated to the Action's participants and the scientific community, as well as an outreach section, targeting at the broader society. All the Action's participants will be able to write articles and share data and information on the website. The Action website will also inform on the progress of the Action, as well as on past and forthcoming events. The DB will also organize an annual research and outreach award for female researchers and ECI.

## 3.3. Network as a whole

25 COST Countries have participated in the preparation of the Action, or otherwise indicated their interest. This interest by a significant number of COST member countries shows the pan-European relevance of the proposed Action. The inclusiveness ratio is already 36%, which shows the different level of national organization and support for CS. The Action will actively address this imbalance of recognition of CS / unequal access to knowledge and will elaborate a stakeholder engagement strategy to identify and integrate especially participants from ITCs. Further measures to foster ITC participation are for example holding meetings in these countries to increase visibility. Established researchers and implementation agencies in ITCs will serve as facilitators. Two International Partners Countries have also joined the Action. Their participation will facilitate the input of expertise

from other regions as well as international coordination of standardization efforts and distribution of Action outputs.

More than half of the Proposers involved in the preparation of the proposal are female researchers. During its lifespan the Action will take targeted measures to further gender balance and the promotion of female researchers and scholars, such as awards, STSMs, etc. One third of the Proposers already involved are ECI. The Action will seek to increase this number and actively encourage the participation of more ECIs in leading roles by measures, such as suggesting them as key authors, the seminar leads, etc.

This Action encourages interdisciplinary and inter-sectoral collaboration as the Network includes a wide range of disciplines, stakeholders, experiences, and bodies of knowledge, which are all necessary to reach the stated objectives. The large number of Secondary Proposers in biological sciences reflects the significant role played by CS in conservation and ecology, a model that the Action seeks to investigate and adapt to other sectors.

The Network of Proposers involves academic researchers and other key stakeholders, such as representatives of scientific museums, European Agencies, and social innovators. The researchers involved in this Action conduct research on CS in projects funded both at the national and European level. Representatives of scientific museums have a solid and established experience in developing and conducting CS projects, and social entrepreneurs have experience with public engagement with policy-decisions. Several Secondary Proposers are also members of relevant networks/associations and have participated in other COST Actions in areas contiguous to that of this Action. The basis for collaboration between Secondary Proposers stems from a) mutual interest in CS; b) a wide distribution by sub-field of science; c) diverse professional background (e.g., science museums, social innovation), and d) diverse national experiences with CS. Once established, the Action will welcome additional contributors, including new and unanticipated inputs that may require change in plans but which constructively contribute to fulfilling the main aim of the Challenge. Special efforts will be made to widen the participation of ITC and seek involvement of ECIs.





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