Knowledge for Change:
A Decade of Citizen Science
(2020—2030) in Support of the SDGs

Report on the Citizen Science SDG Conference
Official event of Germany's 2020 EU Council presidency
14—15 Oct 2020, Museum für Naturkunde Berlin

Key results

Citizen Science has an untapped potential to address the challenges of sustainable development and future life on planet earth.

Citizen Science is a way to ensure that the views of citizens and diverse stakeholders are taken into consideration when shaping science agendas and research projects.

By connecting science and society and combining theoretical knowledge with practical expertise, Citizen Science fosters social and scientific innovations.

Citizen Science is an open, transdisciplinary and inclusive approach to tackle novel scientific knowledge and research agendas in support of the SDGs.

Key questions

How to harness the benefits of citizen science for the SDGs?

How to strengthen citizen science and its connections with other local and global communities to critical inquiry and (self-)reflection?

How to strengthen future Citizen Science systems where everybody's voice can be heard?

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Forewords

Johannes Vogel
Director General, Museum für Naturkunde Berlin

We need to act towards resilient societies, a sustainable future, for democracy and for nature. Only a thriving democratic knowledge society can foster, enable, and subsequently deliver, the urgently needed social and scientific innovations for deep change, delivering a healthy human community on a functioning planet.

The SDGs are the first comprehensive global agenda to sustainably secure the future for generations to come. But what is the best way to support and achieve the SDGs? How can we achieve real change? More lofty words and political declarations are not enough, as the activists of the Fridays for Future movement clearly and rightfully point out. How to get into action is one of the central questions of our present.

We have to act across all sectors of society, to find democratic and knowledge based solutions for societal transformation towards a sustainable future. Only integrated social and scientific innovation will enable humanity to face up to the enormous challenges, in particular run-away social inequality and the ongoing and devastating destruction of nature on our planet. The interplay between democracy, society, business, science and nature needs to be re-calibrated in order to address the imminent threats to human society. For me, this means challenging the workings of entrenched players and deeply held traditional assumptions. Many of these out of date or toxic assumptions are holding people and organisations back. They are prevalent in science, society and business.

The global climate, biodiversity and societal emergencies demand deep and fast transformation. We need new coalitions of the willing, we need deep listening, co-production, inclusion and leadership. Citizen Science is a strong approach for supporting these goals and to get into acting together towards a livable future. It brings together citizens and scientists, policy makers and business partners, enables life long learning and can act as an incubator for new ideas and solutions for pressing problems. We need these solutions at all levels and all scales.

Our sincere thanks go to the European Commission and the BMBF, who have not only made this conference possible, but have also taken important steps in recent years to promote Citizen Science, participation and thus safeguarding and fostering the democratic knowledge society.

For Nature, for Democracy!

Michael Meister
Parliamentary State Secretary, Federal Ministry of Education and Research, Germany

The Federal Ministry of Education and Research (BMBF) attaches great importance to increasing participation in research and science communication. In order to solve the major challenges outlined in the Sustainable Development Goals (SDGs), we need ambitious measures that involve people, communities and organisations across national borders.

Many global challenges are in plain sight and can only be studied at the local level. In this context, citizen science — citizens who contribute to research by collecting and analysing data directly on the ground — can make an important contribution.

An example of a successful citizen science project is our national "Plastic Pirates" campaign which has been running since 2016 and which we are implementing during the German Council Presidency under the motto "Plastic Pirates — Go Europe!". Young people aged between 10 and 16 have the chance to address the topic of plastic waste in the environment, particularly in rivers and oceans. They collect water samples near their homes, analyse the microplastics and macroplastics pollution and make the results available to researchers.

This is a win-win situation for everyone. Direct involvement in the research process enables citizens to see how research helps solve both everyday problems and global challenges. This type of research is not an abstract concept but a hands-on experience. At the same time, the scientific community benefits from the knowledge of the many. This helps to shorten innovation cycles and to introduce new perspectives in research.

In this context, European cooperation is essential to ensure that the productive joint efforts of science and civil society will be useful beyond national borders — after all, problems know no such national borders.

We, therefore, aim to place a greater focus on cooperation with civil society to further develop the European Research Area. The German Federal Research Ministry has launched a special funding programme called "Innovation Union Europe" whose objectives include strengthening transfer between science and society all over Europe. The European Research Area will become a driver of change if science, industry, society and politics are active partners in the generation and dissemination of knowledge. The reorientation of the European Research Area including greater involvement of citizens in science is a key common objective of the Trio Presidency of the Council of the EU of Germany, Portugal and Slovenia in the field of research and innovation.

However, despite all these activities and the potential outlined here, we still have a lot of work to do. The BMBF has supported citizen science since 2013 by organising dialogue processes, establishing networks and infrastructures and providing funding for specific projects. One example is our second citizen science funding call. This has allowed us to gain experience and implement new ideas. However, we must continue to explore and evaluate citizen science. The high requirements and expectations regarding citizen science must be based on insights into best practices and procedures.

Supporting research will help us answer these questions in the coming four years. We aim to have our past funding activities and our new citizen science projects evaluated so that we can make informed decisions as we continue to develop our funding policy.

Our objective is to enable citizens to play an active role in research and innovation and to provide the scientific community with appropriate conditions for a wide variety of participation processes. This will help build confidence between science and society and allow us to take a joint approach to solving global challenges.

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Forewords

Signe Ratso
Deputy Director-General European Commission
DG Research & Innovation DDG3

Recent years have shown just how important it is to align research and innovation with the needs, values and expectations of society. Involving citizens in the shaping of research and innovation policies, in the co-design of research agenda and in the co-creation and co-assessment of scientific knowledge and innovations enables the collection and analysis of new qualities and quantities of data, increases the robustness and relevance of outcomes, and improves the relationship between science and society — all essential to ensuring science and innovation play their role in responding to the challenges we face.

Citizen science, broadly speaking the voluntary participation of non-professional scientists in 'doing research', is one of the main ways we can do that. And citizen science is experiencing significant growth, with the establishment of numerous policies, national networks, and many new projects across Europe.

Much of this is due to heightened awareness and concern about issues such as public health and climate change — issues the general public recognises as crucial. But it is also because new technologies have made it increasingly possible for the public to contribute to research in diverse ways that fit in with their lives. A recent Eurobarometer (EB516) confirmed very high levels of support for science and innovation, high expectations of new technologies, and a significant and growing engagement with science across Europe.

The European Commission has been supporting engagement in research for many years in its policy and funding programmes. In the last Framework Programme, Horizon 2020, we supported citizen science projects covering all areas of science and innovation: from public health and ecology to computer science and frontier physics. In addition to projects that conducted science with citizens, we also supported projects examining the impacts and implications of citizen science, and those that established hubs of activity to foster growth and encourage best practices.

Horizon Europe, our new programme, draws on these experiences and represents a step change towards more societally engaged forms of research. The programme prioritises co-design and co-creation, evaluates proposals specifically on societal engagement, and one of its pathways to impact starts with 'co-creation with citizens and end-users'.

A novelty of Horizon Europe is its Missions — on adaptation to climate change, beating cancer, restoring oceans and waters, smart cities, and healthy soils. Missions will comprise portfolios of different kinds of actions to achieve bold, inspirational and measurable goals within set timeframes. These portfolios will give prominence to user-led innovation, citizen science, and public engagement activities, allowing the added value of complementary modes of research and innovation to be brought to bear to solve societally important issues. As part of the renewed European Research Area, a Europe-wide citizen science campaigns on Plastic Pirates is launched in synergy with the oceans and waters Mission.

This collaborative approach to research and innovation presents a big challenge to European research and innovation actors. They will need to work with new interlocutors and organisations to make this a reality, and train, recognise and reward researchers to engage. The European Commission addresses obstacles to more and higher quality engagement through facilitating reform of the research and researcher assessment system, promotion of institutional changes towards open and responsible research and innovation in organisations such as universities, and by improving the training and recognition of citizen science in research careers.

The CS-SDG conference was an important milestone in these developments. It highlighted the myriad of ways that citizen science can work towards and support the Sustainable Development Goals and brought together many of the key actors from around Europe and beyond to became a springboard for further action. I'd like to congratulate the Museum für Naturkunde Berlin and the German Presidency on a crucial and timely conference in helping work towards achievement of the Sustainable Development Goals.

Citizen Science Policy — A Panel Discussion
— Conference highlights

The conference started with a podium discussion with high level experts from policy, museums, science and science funders, who discussed insights into citizen science in Europe and provided inspiring steer for the future development of citizen science.

"Empowerment is not possible without giving away something. There is a need for cultural change. It will also be important to balance the expectations of citizen science. There should be an equivalent 10 per cent investment of all the funding which goes into [disciplines like] physics to progress citizen science every year."

Muki Haklay
Professor of Geographic Information Science, University College London (UCL), United Kingdom

The panel discussion was facilitated by **Susanne Hecker, Museum für Naturkunde Berlin**, and **Aletta Bonn, Helmholtz-Centre for Environmental Research — UFZ/German Centre for integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig.**

"In order to achieve the SDGs, we need to combine academic knowledge with societal knowledge. Challenges are so complex that there is a need of a more systematic approach to cope with these challenges. Transdisciplinary research is therefore very important. Citizen science can leverage the effort. Therefore, we should invest in enlarging the community, which would like to be involved in citizen science projects. It helps the democratisation of Science."

Klement Tockner
President FWF Austrian Science Fund, Austria

"Citizen Science is a key to our knowledge society and to all relevant stakeholder researchers. Trust is the most important thing, between society and the research community. Citizens can play a key role in monitoring SDGs."

Michael Meister
State Secretary, Federal Ministry of Education and Research (BMBF), Germany

"The European Commission has supported the rise of citizen science of recent years [. . . and] expects citizen involvement to become an integral part of the Horizon Europe programme. Society needs to be involved alongside academia, industry and public authorities to conduct research and develop innovations — one of the main priorities of EU policy support. Citizen Science contributes to monitoring the implementation of EU environmental legislation [and] progress on international commitments such as SDGs."

Signe Ratso
Deputy Director-General, DG Research and Innovation, European Commission

"Citizen Science has a degree of freedom and should not only support policy like SDGs. The focus [of EU funding] should be on the citizens, it should be invested in communication and capacity building processes. "

Katrin Vohland
Director at the Natural History Museum Vienna, Austria

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Keynotes

WHAT IS CITIZEN SCIENCE, ANYWAY?

Muki Haklay
Professor of Geographic Information Science at University College London (UCL) and founder and Co-director of the UCL Extreme Citizen Science group, United Kingdom

While at first sight, the meaning of citizen science seems to be clear — being about the participation of members of the public in the research process in a way that directly contributes to the creation of novel knowledge — a more accurate definition has been challenging the field of citizen science throughout its development. A recent effort of analysing over 35 different definitions demonstrated the subtle differences and the areas of contention. What level of cognitive engagement do we expect from participants? If they pay to participate in a project, is that OK? In what situation should the participants get paid, or is that no citizen science? And what about if the project is led by a for-profit company?

These and many other questions about what should be considered as a citizen science activity are increasingly becoming more important. For example, when setting up a national or international platform for sharing citizen science projects and deciding which projects will be included. This is also the case when creating a new funding scheme to support citizen science for the SDGs and setting criteria for evaluating funding applications. Citizen science features a special complexity, since the definition of what can be considered citizen science activity may vary between disciplines and practices.

The keynote described a process that was carried out at the end of 2019 and the beginning of 2020 to identify common characteristics of citizen science projects through a survey of views about case studies (vignettes). They reached out to people in research, science communication, policy and the public domain in order to obtain a wide range of views. Based on 330 responses and over 5,000 gradings of 50 vignettes, it was possible to identify the area of agreement and disagreement. We developed ten factors of citizen science, namely activeness, compensation, purpose, purpose of knowledge production, professionalism, training, data sharing, leadership, scientific field, and involvement plus 60 sub-factors. The survey clarified the range of views regarding citizen science within the community of practice and interest in citizen science. The aim of the study was not to describe everything that is citizen science, but rather to identify the areas that require attention and guidance when a definition is being developed. In the process, existing definitions and criteria were accommodated. The guidance covers 1) core concepts, i.e. terms and concepts that can influence the decision regarding a project, 2) disciplinary aspects with different areas of science that have specific issues with participatory research, 3) leadership and participation, 4) financial aspects, such as scientific research payments and incentives for participants, and 5) data and knowledge, e.g., open science, data ownership and quality. The ECSA characteristics of citizen science can be used within policy processes or panels, and for discussions about the challenges that they present to the development of the field. These characteristics can be integrated into efforts of aligning citizen science activities with the SDGs.

CREATING AN ENABLING ENVIRONMENT FOR CITIZEN SCIENCE IN EUROPE

Anna Panagopoulou
Director of the Common Implementation Centre and Acting Director of the Research & Innovation Outreach, DG RTD, European Commission

In recent years, citizen science has grown from simply demonstrating that it can have value, to ensuring it is conducted to the highest standards of practice. None of this would have been possible without the dedicated efforts made by citizen science practitioners and citizens themselves. Citizen science facilitates increased awareness and concern about issues such as climate change and biodiversity loss. New technologies have emerged that make it increasingly easy for the general public to continue to research in diverse ways. This has been matched by efforts to ensure the very highest standards of ethical practices, inclusion and data quality in citizen science activities. In short, we have come from demonstrating that citizen science can have value to consolidating learning and historic integrity, that we are able to embed citizen science in research processes and even mould policy monitoring mechanisms. The European Commission has been supporting societally-engaged research, particularly with respect to science societal programmes. Over time support has gone from primary researchers-led research projects to multi-stakeholders, co-design and co-creation projects involving actors including citizens.

Efforts began in Horizon 2020 and will continue in Horizon Europe. In fact, Horizon Europe promises to be a step-change towards collaborative forms of research, and this represents a serious challenge to the citizen science community, other research and innovation actors, policymakers and funders. The European Commission has promoted the Responsible Research and Innovation throughout all parts of Horizon Europe programmes. Responsible Research and Innovation aims to encourage societal actors, including citizens, to work together with academia during the whole research and innovation process with the aim for innovation and its outcomes with the values, needs and expectations of the society. More than 2,500 projects have engaged a wide variety of societal stakeholders.

Despite the important results that every citizen science project has in its own right, we need to also promote changes within research funding and performing organisations such universities and museums. Such institutions should become enabling environments for citizen science. Research and innovation will be inclusive and open as possible with regards to gender, age and ethnicity and address and provide solutions to important issues of society. We need to achieve social impact and foster trust in science and innovation. The more collaborative approach presents a significant challenge for the European research and Innovation system. It requires institutions to do activities in new ways and funders and policymakers to agree on how to promote good practices and incentivise social outreach and citizen science.

First, it requires the expertise present at this conference, the networks, and the organisations that have been involved in science with and for society to work with new constellations of Europe. This will put the practice, know-how and capabilities into place. Second, it requires targeted support to research performing organisations and therefore supporting institutional changes. Finally, in partnership with other authorities across the European research area it requires us to raise the profile of societal engagement, promote engagement activities in research studying and performing organisations and organize Europe-wide citizen science campaigns that raise awareness of important issues while doing excellent science. Only by collectively supporting citizen science and opening governance up across stakeholder organisations will we come to see citizen science playing its full role in supporting and working towards the Sustainable Development Goals by 2030.

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CITIZEN SCIENCE FOR MONITORING AND ACHIEVING THE SDGS

Jillian Campbell
Head of Monitoring, Review and Reporting
at UN Convention on Biological Diversity, Canada

At the moment, major gaps in being able to monitor the environmental dimension of the SDGs and the environment more broadly exist. Sixty-eight per cent of the environment related SDGs lack data for global monitoring. Citizen scientists collect data that can be used to fill these gaps. However, citizen science and citizen generated data is currently underutilised in monitoring the SDGs and in official monitoring more broadly. This is due to a lack of awareness of the scope and availability of citizen science data, difficulties in accessing and integrating data, a lack of availability of information on methodologies and quality assurance and the need for guidance and demonstrations of how citizen science can be used. UNEP has been working to demonstrate the value of citizen science data for global and national monitoring of SDG 14.1.1 on marine litter. Not only have we been able to develop products that improve local, national and global tracking of SDG 14.1.1, but the information generated can also feed back into communities and serve to stimulate citizen engagement, highlight where beach clean-ups are needed, stimulate activism related to reducing single-use plastic and increase interest in protecting the marine environment. Marine litter is just one example. It could be replicated for other SDGs and for other areas of official statistics, for example, the monitoring of the upcoming Global Biodiversity Framework. Citizen science not only has the potential to fill data and information gaps, but also to inspire citizens to engage — only when citizens, policymakers and scientists work together will we be able to achieve the SDGs.
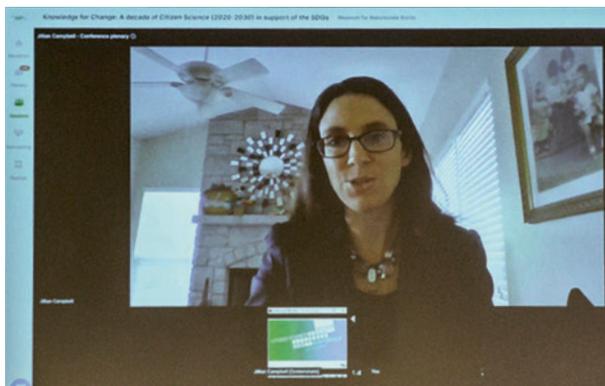
ENHANCING SOCIAL DIMENSIONS IN CITIZEN SCIENCE: SDGS AND SOCIAL TIPPING POINTS

Josep Perelló
Associate Professor in the Department of Condensed Matter Physics at the Universitat de Barcelona and the Universitat de Barcelona Institute of Complex Systems, head of the OpenSystemsUB research group, Spain

The pursuit of sustainable goals entails substantial technological and scientific advancements. However, commitment and cooperation from vast segments of our societies is also required to turn the efforts into actions. Just a mention a straightforward: climate stabilisation is not only a scientific and technological task, but it also depends on activating processes of social change on several levels. An interesting concept to raise here is the social tipping point, which is a point where a group rapidly and dramatically changes its behavior by widely adopting a previously rare practice. The concept, taken from the field of behavioural sciences, has strongly emerged in climate literature but it is potentially of interest to face any other urgent societal challenge. Due to its participatory spirit, citizen science provides a framework to further reflect on the notion of social tipping point and integrate social dimensions into any specific SDG oriented research activities. Grounded on the current CoAct EU project, the presentation discussed a general model for a citizen social science that offers communities, groups or individuals the possibility to directly intervene into scientific research and to then actively contribute to SDGs. Citizen social science engages citizen bodies concerned with specific social issues in co-research and imagines the possibility to support demands of the public with scientific evidence. One way to enhance the social dimensions is to engage in unusual partnerships and cooperation with other entities

and stakeholders such as in art, culture or civil society activism. In addition, citizen science should take place in public spaces wherever possible to foster dialogue with the community. The joint effort itself represents a way to reinterpret scientific practice, much closer to collective action and policy making and very much linked to public debate. The presentation drew on experiences from contexts such as climate justice, mental health care provision, air pollution exposure (e.g., xAire), gender biased interactions in public spaces among others to encourage a further enhancement of social dimensions in citizen science practices if they want to more effectively support SDGs.

OPENNESS AS A PATHWAY TO SUPPORT SDGS: AN EXPLORATION OF SCIENCE-SOCIETY MEDIATION SPACES

Thomas Hervé Mboa Nkoudou
President of the Association pour la Promotion de la Science Ouverte en Haïti et en Afrique (APSOHA), Cameroon

We should grant power to citizens in a way that they can better frame the SDGs according to their local needs wherever they are across the world. The link between open science, citizen science and openness is a very intriguing avenue to explore. According to Chan et al. (2020), the following dimensions of openness constitute open science: openness to publications and data, openness to society and openness to excluded knowledge and epistemologies. Citizen science is a suitable approach to contextualize SDGs and anchor them in the Commons. However, we must avoid falling into the trap of the instrumentalisation of citizen science by exploiting citizens through their pseudo-participation. Science-society mediation spaces are

therefore an important driver to enable a fair engagement of citizens in support of the SDGs. Such spaces can be for example: events, associations, public debates bringing together researchers and non-researchers, popular journals and magazines, virtual platforms, visits by researchers to schools or high schools, information watch activities, science shops and makerspaces and many more. The maker movement especially exemplifies how digital technologies have created new forms of openness to society within technoscience. The maker movement is a combination of the hacker ethics, Do It Yourself and the freedoms conveyed by free software.

The collaborative manufacturing spaces where the maker movement is taking place are known under different names, such as makerspaces, hackerspaces, fablabs, and so on. AfricaOSH Summit, for example, is a grassroots effort to explore alternative paths to education, research, scholarly communication, science and technology. This maker movement focusses on building equipment based on the local needs of a community, e.g., for quality measurements of drinking water. AfricaOSH is a community of makers, hackers, practitioners and researchers of government officials, private sector players and civil society across the African continent, the global south and the world. The beauty of citizen science is its ability to bring people together, regardless of their experience or academic background, and it openly discusses the local needs of the community, thereby enabling citizens to make use of their own capacities and expertise to contribute to science.

Sessions

Theme 1
—
Addressing global challenges

CITIZEN SCIENCE FOR HEALTH AND WELL-BEING

SESSION CHAIRS
Xavier Basagaña, Barcelona Institute for Global Health, ISGlobal, Spain | **Valeria Righi,** Ideas for Change, Spain

SPEAKERS
Isabelle Dechamps and Teresa Schäfer, Prototypes for Europe, Germany | **Nils Heyen**, Fraunhofer Institute for Systems and Innovation Research ISI, Germany | **Yaela Golumbic**, SCOPE Group, School of Chemistry, University of Sydney, Australia | **Rosa Arias,** Fundación Ibercivis & Science for Change, Spain | **Elisabetta Broglio**, Centre for Genomic Regulation, Spain

Citizen science is increasingly being used to address a variety of issues related to health and wellbeing, a topic linked with SDG3 (ensuring healthy lives and promoting well-being for all), SDG1 (ending poverty), SDG11 (sustainable cities and communities) and SDG13 (climate action), to cite a few.

Projects that tackle health issues often face the challenge to bring together actors from different backgrounds. A successful case in this regard is the ❯ Careables project, presented by **Isabelle Dechamps** (Prototypes for Europe) and **Teresa Schäfer** (Centre for Social Innovation Vienna). The project gathers designers, healthcare professionals and care receivers to co-create inclusive healthcare solutions and it documents the co-creation process in order to foster its replicability and impact at scale.

The power of co-creation in multidisciplinary teams was also illustrated by the ❯ Genigma project, presented by **Elisabetta Broglio** (Centre for Genomic Regulation). This project is co-designing a game to analyse genome fragments from real cancer cells, which can ultimately be used for personalised treatments. The co-creation process involved researchers, gamers, teachers, artists and communicators to get innovative solutions to a complex problem.

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One of the main benefits of citizen science in health research is that it harnesses patients' expertise to improve the real-life value of the results. This was well-argued by **Nils Heyen** (Fraunhofer ISI), who presented a ❯ pilot study on cystic fibrosis. The study documents the everyday problems of subjects with the disease, revealing how working with patients who lack physical resilience might have implications in their degree of involvement.

Yaela Golumbic (University of Sydney) presented ❯ E$$ENTIAL MEDICINE$, a project that is using the power of the crowd to gather information on the availability and costs of essential medicines around the world. By following the principles of open science, the project aims to break down barriers to information and promote accessibility of medicines to all.

The area of health is very broad, and projects do not necessarily need to deal with patients or medicines. An example is ❯ D-Noses, presented by **Rosa Arias** (Fundación Ibercivis), which deals with odour pollution, an issue that can be linked to sanitary problems. The project is empowering citizens to monitor their environment by using an app to map odour observations in their living environment.

Overall, the projects presented in this session show how citizen science in the health domain is a key instrument to address pressing social problems in an inclusive and fair way.

MOBILITY AND RENEWABLE ENERGY FOR SUSTAINABLE CITIES AND COMMUNITIES

SESSION CHAIR
Kris Vanherle, Transport & Mobility Leuven, Belgium

SPEAKERS
Martina Hertel, Difu - Deutsches Institut für Urbanistik / German Institute of Urban Affairs, Germany | Daniel Wuebben, Universidad de Rey Juan Carlos, Spain | Luisa Barbosa, Studies Centre on Science, Communication and Society - University Pompeu Fabra, Spain | Kris Vanherle, Transport & Mobility Leuven, Belgium

One of the key challenges for our future on a healthy planet is to create sustainable cities and communities with sustainable energy and mobility. Citizen science has a great potential to involve society in this process with creative ways and true-to-life issues. How can we produce scientific knowledge in the field of mobility and transport through citizen science? And how can this knowledge and data affect policymaking on transportation and mobility?

In this regard, **Martina Hertel** introduced the Horizon 2020 project Park4SUMP, which aims to integrate the topic of parking management into Sustainable Urban Mobility Planning (SUMP). Unlike traditional planning methodologies, PARKPAD actively includes citizens and stakeholders in a co-creation process taking into account that parking is more than a transport related matter. The focus lies in moving from an operational and reactive parking policy to a more strategic one. This encompasses objectives like increasing health and well-being by a more equitable distribution of public space and reducing car travel while increasing walking and cycling or public transport.

Daniel Wuebben highlighted the missing link between community renewable energy and SDGs even though citizen science and community renewable energy each advance SDGs such as 7) Affordable and Clean Energy; 11) Sustainable Cities and Communities, and 13) Climate Action. What kinds of materials, methods, and spaces will allow CS to increase citizen engagement with community renewable energy and the broader clean energy transition? For example, one powerful tool to enhance awareness and foster engagement is to share power usage and excess within a community in real time.

The deployment of clean and affordable energy (SDG7) is key towards a sustainable future and requires a strong participation of all societal actors. When considering solar energy, which is the only fully democratic type, **Luisa Barbosa** emphasised that citizens should be especially active protagonists of research and innovation. There is a lack of enthusiasm or knowledge to engage citizens within this clean energy undertaking, valuing their skills to actually contribute to the scientific endeavour and decision-making. One game changer experience is the EU-funded Project GRECO. The app now has more than 22MW of solar energy reported from 71 installations. With this experience, GRECO helps establish a paradigm for engagement in research into clean and affordable energies.

Kris Vanherle presented the H2020 project WeCount (Citizens Observing UrbaN Transport), aiming to empower citizens to take a leading role in the production of data, evidence and knowledge around mobility in their neighbourhoods, and at street level. The project employs participatory citizen science methods to co-create and use innovative low cost, automated, road traffic counting sensors and multi-stakeholder engagement mechanisms in five pilots in Madrid, Ljubljana, Dublin, Cardiff, and Leuven. These devices are unique in the sense that citizens play a key role in the data-collection process, directly contributing to a participatory bottom-up approach in urban mobility planning. In viewing the current situation in transport, data on travel behaviour will be crucial in the future when it comes to identifying needs and transport shortages in urban areas.

CITIZEN SCIENCE FOR SUSTAINABLE EDUCATION

SESSION CHAIRS
Gitte Kragh, Centre for Science Studies and ScienceAtHome, Aarhus University, Denmark | Jacob F. Sherson, Director and Founder of ScienceAtHome, Aarhus University, Denmark

KEYNOTES
Jacob Sherson, ScienceAtHome, Aarhus University, Denmark | François Taddei, Centre de Recherches Interdisciplinaires (CRI), Paris | Carol O'Donnell, Smithsonian Science Education Center, United States

SPEAKERS
Thomas Kox, University of Munich, Germany | David Kocman, Jožef Stefan Institute, Slovenia | Claire Ramjan, University of Stirling, United Kingdom | Daniëlle Meuleman, Naturalis Biodiversity Center, Netherlands | Samantha Mason, Durham University, United Kingdom | Yoseph Araya, The Open University, United Kingdom

Embedding citizen science (CS) and the Sustainable Development Goals (SDGs) into teaching curricula and education practices can empower people to understand, engage with and help solve local and global challenges, now and in the future. This can be done in many innovative ways, one being through the use of games in educational contexts. **Jacob Sherson** (ScienceAtHome, Aarhus University) demonstrated how Research-enabling Game-based Education ❯ (ReGAME) extends the Inquiry-based science education (IBSE) approach by embedding CS challenges – where the solution is not known unlike in IBSE – into the core curriculum. A grand challenge is then facilitating the ensuing discussions and learning for the students through use of scaffolding tools, for example using the digital tool, the ❯ Citizen Science Notebook. A recurring theme was the challenge of how best to engage children and youth in CS and SDG-related activities. There was a general call for learners to be involved right from the outset, essentially through a CS of Learning (SDG4), just like there is CS for other SDGs.

Francois Taddei (Centre de Recherches Interdisciplinaires) advocated for including learners in a co-design of what the best ways for them in their contexts are to learn about the SDGs, get to be problem solvers, and understand their local conflicts influencing the SDGs.

Francois Grey (Citizen Cyberlab, University of Geneva) presented an example of practical implementation of the call for a crowdsourced co-design process for young people to generate innovative ideas to address SDG challenges using the social network, Goodwall, in the ❯ Crowd4SDG project. Many young people have too ambitious and unrealistic ideas but through an iterative co-creation process, ideas are distilled and honed to become realistic, powerful and sustainable ideas, implemented in local contexts.

The local context and student engagement within communities is also crucially important in the ❯ Smithsonian Science Education Center Global Goals programme, director **Carol O'Donnell** explained. The open-ended curriculum is based on the SDGs to empower youth to discover the socio-scientific issues, understand the underlying science of the issues, and finally act to use their new scientific knowledge to do social good in their local community.

Claire Ramjan explained how participation in CS projects encouraged students to consider the human impacts on the environment, though the question was how to turn such considerations into actions with and for the environment. Several presenters gave innovative and explorative examples of just how students can take action. For example **Thomas Kox** shared how students acquired knowledge about weather, created DIY weather stations and helped collect and report local weather data through the KARE-CS project. **David Kocman** shared how it was possible to complete all CitieS-Health project phases (identification of research question, co-design, deployment, and action) in one day with a local school on the topic of noise and health.

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Daniëlle Meulenman involved disadvantaged children in nature experiences and CS through the nature club 'Nature around the Corner'. Participation gave children a more positive attitude to nature and allowed them to discover their passion and take action for nature in their local community.

Samantha Mason and the MammalWeb project has worked with over 100 schools on camera trapping of local wildlife. Students gained an increased knowledge of local species, felt more connected to nature and improved their mental well-being through their participation. Teachers also benefited from participating and some changed their teaching practice to engage more with the outdoors.

And finally, **Yoseph Arraya** revealed how a CS initiative with macadamia farmers in Malawi gave undergraduate students a unique opportunity to learn about and engage with practical and life-sustaining work, linked to the SDGs. The overall conclusions were that CS has an important place in education for the SDGs; crowdsourcing and co-design of learning should be encouraged more; students, teachers and CS projects all benefit in a multitude of ways; and there is almost no limit to the innovative, creative opportunities to embed CS and the SDGs into curricula to empower learners to take action for the SDGs.

CITIZEN SCIENCE FOR RESPONSIBLE FOOD CONSUMPTION AND PRODUCTION

SESSION CHAIRS
Ina Opitz, Museum für Naturkunde Berlin, Germany | **Anett Richter**, Thünen Institute of Biodiversity, Braunschweig, Germany

KEYNOTE
Anett Richter, Thünen Institute of Biodiversity, Braunschweig, Germany

SPEAKERS
Jessica Amprako, University of Kassel, Germany | **Rachel Pateman**, University of York, United Kingdom | **Siri Carson,** NTNU, Norway | **Danielle Wilde**, University of Southern Denmark, Denmark | **Fredrik Brounéus**, VA (Public & Science), Sweden

When **Johan Rockström** (Director of the Swedish Resilience Centre) presented the interconnectedness of the SDGs in relation to the food-system, he revolutionised the way we think about the relationships of the SDG with respect to aspects of food production and consumption. Subsequently, it has been strongly argued that several transformative changes are going to be required to achieve sustainability. In our session, presented the practice of citizen science as a format to pathway transformative changes in food systems. Five representative case studies were conferred and policy recommendations developed.

In her presentation, **Jessica Amprako** presented the implementation of citizen science as a tool for the development of sustainable production of aromatic plants in Bangladesh and Pakistan. Her policy recommendations include: more incentives for smallholder farmers as well as educational workshops for local farmers.

After this, **Rahel Pateman** gave insights in the project Food Waste Experiment — that includes a novel method for calculating food waste. Her policy recommendations cover the points: read the priority questions to decide where to focus investment, consider the food system as a whole and further invest in co-created citizen science projects that aim to tackle the issue.

In her talk, **Siri G. Carson** referred to the issue of genome editing for producing novel agriculture and aquaculture products in the realm of biotechnological inventions. Her policy recommendations include: implement diverse forms of non-safety assessments in regulation of genome editing technologies, support funding mechanisms for normative analysis and enhance research-based framing of citizen engagement.

In the fourth presentation, **Danielle Wilde** highlighted the values of transformative society driven processes on the example of a three-course inquiry acting as a bottom-up food system transformation processes. Her policy recommendations address: raise awareness of more biodiverse foods through research and community involvement, subsidise sustainable ingredients to democratise access and build recognition for inclusionary methods in citizen science.

In his presentation, **Fredrik Brounéus** introduced a Citizen Science approach and a tool to quantify food loss and waste across different areas of the food system and to understand causes of food loss and waste. His policy recommendation covers: foster healthy and climate-friendly habits by introducing such menus in schools.

From the keynote and the presentations, we learned that the human food system impacts various SDGs in an interconnected way. In the future it might be important to focus our participative research on specific SDGs to provide specific data or to push learning processes regarding specific pathways towards sustainable development. Additionally, it should be reviewed as to how to involve policy or other decision makers into the participative processes for a better implementation of the research results and insights.

A summary of the session can be viewed here:
➜ https://zenodo.org/record/4454824

CITIZENS IN BIODIVERSITY MONITORING

SESSION CHAIRS

Nike Sommerwerk, Museum für Naturkunde Berlin, Germany | **Jörg Freyhof,** Museum für Naturkunde Berlin, Germany | **Martina Lutz**, Museum für Naturkunde Berlin, Germany

SPEAKERS
Eugenio Gervasini, European Commission Joint Research Centre, Italy | **Cristina Gonzalez Sevilleja,** Vlinderstichting / Dutch Butterfly Conservation, Netherlands | **Inian Moorthy**, International Institute for Applied Systems Analysis, Austria

This session focussed on the integration of citizen research into biodiversity monitoring and thus its current and possible future contribution to national and international reporting obligations. The topic was chosen against the background that monitoring and achievement of the UN Sustainable Development Goals (SDGs) will not be possible via tradtional ways of data collection alone (e.g., censuses / household surveys or university and institutionalised field research when more specifically related to SDGs 14 and 15). Rather, new ways of obtaining data and a much better utilisation of the potential of citizen science (CS) will be necessary to fulfil this herculean task. Studies reveal that CS data are already contributing or could contribute to more than a third of the environmental indicators of SDGs[1]. CS could considerably improve the temporal frequency and spatial resolution of data and thereby complement reporting.

However, CS is not only a source of data that could fill gaps. CS is an important way to mobilise action and get everyone on board to play their part in addressing the world's greatest challenges by engaging the public in scientific research.

Three initiatives (Invasive Alien Species (IAS) in Europe — mobile App; ABLE — Assessing ButterfLies in Europe; Natura Alert: Monitoring biodiversity threats using citizen science — mobile App and web portal) gave insights into their contributions to (i) the official information system supporting the implementation of EU regulations on IAS, (ii) the development of indicators for monitoring of biodiversity trends at the EU level that help to evaluate the implementation of EU's environmental and agricultural policies and (iii) gathering of citizen-powered data for evidence-based decision-making. Three additional initiatives presented their results as posters in the digital marketplace of the conference.

The main outcomes in the session revealed that
a) more information for the CS community is needed on what kind of data requirements are to be considered for monitoring biodiversity indicators (with respect to the SDGs, but also other environmental goals at the European and national level);
b) it would be useful to have a better orientation regarding possible pathways and timelines for data provision;
c) greater attention should be paid to data validation, quality control and integration; and
d) a compilation of best practice examples on "CS biodiversity data fit for reporting purposes" would be helpful.

1 Fraisl et al. 2020, Sustainability Science

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LIGHTNING TALKS

SESSION CHAIRS
Kim Mortega, Museum für Naturkunde Berlin, Germany
Silke Voigt-Heucke, Museum für Naturkunde Berlin, Germany

SPEAKERS
Stavros Katsanevas, European Gravitational Observatory (EGO), Italy | **Marta Soler Gallart**, Universitat de Barcelona, Spain | **Norbert Steinhaus**, Science Shop Bonn, Germany | **Rémy Bossu**, Euro-Mediterranean Seismological Centre (EMSC); CEA, DAM, DIF, Arpajon, France | **Thorsten Kluss,** Cognitive Neuroinformatics, University of Bremen, Germany | **Jóhann Helgi Stefánsson**, The Soil Conservation Service of Iceland, Iceland | **Giulia Barbero Vignola**, The European Commission Joint Research Center, Italy

Lightning talks are there to enable the audience to review as many potentially exciting ideas as possible in a short space of time. In this session, projects with citizen science activities and achievements presented their work in relation to diverse themes relating to the SDGs.

Stavros Katsanevas presented the EU-funded SWAFS REINFORCE project. It aims to develop a multi-sensorial apprehension of the definitions of cosmos, explore the potential of frontier citizen science for inclusion and diversity; go beyond established traditional disciplinary frontiers of the modes of apprehension of reality. REINFORCE develops a participatory process, amalgam of "contributory" and "co-created" citizen science. It will create a policy roadmap, as a paradigm for other research infrastructures wanting to implement citizen science projects in the EU and beyond.

The H2020 SOLIDUS project — Solidarity in European societies: empowerment, social justice and citizenship — draws on identifying the relevant drivers and barriers in relation to the spatial dimension of solidarity. **Marta Soler Gallart** provided results of successful acts, which are proven to overcome geographical and social inequalities while also enhancing spatial and intergroup solidarity with respect to housing, education, employment, health and civic engagement. The project explores to what extent they respond to dialogic and inclusive processes, along with related outcomes and policy developments for overcoming the consequences of the economic crisis, while reducing social inequalities, strengthening social cohesion and increasing well-being.

Norbert Steinhaus has postulated that the climate is currently unfairly overshadowed by another (un)expected global affair, yet its manifestations and influence are nevertheless fiercely experienced across the globe. However, if we can view it as an opportunity for translating a message – set around similarities and basically very same nature of causes of climate changes and pandemic burst – we may be able to initiate wider citizen engagement by empowering critical understanding of processes in nature and humans' interference and contribution to their consequences. The H2020 project TeRRIFICA was conceived around the idea that a bottom-up approach,

the integration of all relevant stakeholders and all related aspects along climate policy and action, and the direct involvement of citizens in all phases of creation of climate actions are central and necessary.

The Euro-Mediterranean Seismic Centre (EMSC), a foremost earthquake information centre, detects messages on Twitter following an earthquake as well as surges on its website or app when eyewitnesses rush to find information. These "crowdsourced" detections are reported well before seismic networks publish their results, allowing it to rapidly engage with eyewitnesses. **Rémy Bossu** highlighted the associated platform LastQuakers, which provides a space for citizens to exchange and learn about earthquakes, regardless of their prior knowledge and cultural beliefs. Through offering open, participatory and free education, LastQuakers empowers communities and improves community resilience.

The project Bee Observer - BOB targets data collection in beehives with an IoT approach (1) to make a dataset publicly available for research purposes and (2) to develop a smart assistance for beekeepers in practice. Citizens have been included in the research process from generating hypotheses, developing sensors, assessing and evaluating data. **Thorsten Kluss** highlighted that a nationwide sensor network makes ecosystem interactions visible and quantifies critical influencing factors. The open knowledge structure facilitates communication between different educational backgrounds as well as lifelong, inclusive learning. Urban beekeeping cooperatives enable decentralised management and alternative economic practices.

GróLind is a collaborative project with the aim of monitoring Icelandic vegetation and soil resources. **Jóhann Helgi Stefánsson** emphasised that GróLind is a

collaborative project and cooperation with stakeholders, such as the science community, landowners and others, is a fundamental concept in the project. A citizen science project is being developed wherein land users will annually monitor the conditions of the land they utilise. Land users' participation provides more extensive and accurate monitoring, both spatially and temporally. Cooperation between scientists and land users increases the flow of knowledge and trust between groups, ensuring that the knowledge gained will be used for sustainable land management.

SDGs are at the core of all EU and national policies, and the COVID-19 emergency exemplified further the necessity to rebuild the socio-economic-environmental system of Europe according to their embedded principles. There is now more than ever the need for swift actions at all levels of society to make sure that the recovery strategy does indeed bounce the EU forward, towards pathways that facilitate the achievement of SDGs. Numerous studies have highlighted the fact that behavioural changes on an individual level can have positive impacts on tackling climate change and other environmental concerns. Raising awareness of the complex implications of consumer choices, can foster the engagement of citizens towards sustainable development. **Giulia Barbero Vignola** presented a "consumer footprint calculator" tool developed by the JRC. This tool enables illustrating the impacts of individual choices on more than 15 different environmental aspects.

Sessions

Theme 2
—
Concepts and methodologies for the SDGs

EVALUATION OF PROGRAMMES AND PROJECTS: INSTRUMENTS, OUTPUTS, OUTCOMES PART 1 + 2

SESSION CHAIRS
Nicola Moczek, Museum für Naturkunde Berlin, Germany
Barbara Kieslinger, Centre for Social Innovation, Austria

SPEAKERS
Sabrina Kirschke, UNU-FLORES, Germany | **Carmen Kilvits**, Estonian University of Life Sciences, Estonia | **Laure Fallou,** Euro-Mediterranean Seismological Centre (EMSC), France | **Alexander Gerber**, INSCICO, Germany | **Margarida Sardo**, University of the West of England Bristol, United Kingdom | **Nerea Ferrando**, University of Reading, Earthwatch, United Kingdom | **Giovanni Maccani**, Ideas for Change, Spain | **Antonella Passani, Annelli Janssen**, T6 Ecosystems, Italy

The topic "Evaluation of programmes and projects: instruments, outputs, outcomes" was the most favoured by the participants, resulting in two sessions with a total of eight presenters, who gave us insights into their current work. In particular, we discussed challenges and opportunities in the evaluation of citizen science activities.

The two sessions offered a welcoming space for the exchange of experiences and knowledge around aspects such as: comparative approaches, new tools and technologies for evaluation, moving beyond data collection and revealing long term impact, and the focus of evaluation, namely process-oriented and outcome-oriented.

The focus of evaluation has broadened considerably in recent years, and now citizen science goals are being evaluated on the part of the participation and research process as well as on the part of the volunteer participants. Impact assessment also enables mainstreaming and upscaling by attempting to identify impact for policymakers, funding agencies, and the wider public. This brings new challenges, as researchers increasingly have to deal with social science methods, work in multi-disciplinary teams and engage diverse stakeholders in the evaluation and impact assessment process in a participatory manner. The motivation to volunteer and the motivation to take part in evaluations were mentioned in particular as a challenge. But, in many of the publications, researchers tend to publish only best cases and to neglect negative experiences. Therefore, obtaining an

objective picture of the processes and effects of projects is challenging, and an increased level of mutual learning, also from mistakes, has been suggested. Existing networks are helpful in sharing good practices and highly valuable. They should strengthen the opportunities for mutual learning also between projects of different regions and research fields. The growing numbers of new technologies like apps and tools help to reach a broad audience. But especially in times of temporary lockdowns due to the Covid-19-pandemic most of the participation, measures and methods must be adapted to work remotely. A significant opportunity that the pandemic is offering is to test out new technologies and tools in order to make citizen science work in online, remote or distanced settings. The significant and growing number of citizen science activities will allow comparative designs in evaluations, taking into account their uniqueness, innovativeness, and creativity. This could also contribute to uncovering the potentials and benefits of citizen science for society even further and increase the appreciation of evaluation activities — beyond data collection.

EXPLORING HUMAN-NATURE-RELATIONS: CITIZEN SCIENCE IN THE ANTHROPOCENE

SESSION CHAIRS
Maike Weißpflug, Museum für Naturkunde Berlin, Germany | **Marie Delannoy**, French Museum of Natural History, France

KEYNOTE
Frédérique Chlous, French Museum of Natural History, France | **Maike Weißpflug,** Museum für Naturkunde Berlin, Germany

SPEAKERS
Anna Berti Suman, Tilburg University, Netherlands & The European Commission Joint Research Center, Italy
Emu-Felicitas Ostermann-Miyashita, Leibniz Centre for Agricultural Landscape Research (ZALF), Germany
Barbara Heinisch, University of Vienna, Austria

The Anthropocene — the age in which human influence on the earth's surface and biosphere exceeds natural forces — is a widely discussed concept that blurs the boundaries between disciplines, between nature and culture. Whether and how can citizen science become a convincing research approach to the challenges of the Anthropocene?

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Frédérique Chlous and **Maike Weißpflug** presented a new citizen science project by the Natural History Museums of Berlin and Paris that has the objective of documenting our changing representations of biodiversity losses. The resulting open collection, produced by people, will be an opportunity for many reference narratives on biodiversity changes that should speak to everyone and will tell a human story — or better many human stories — of the Anthropocene. **Anna Berti Suman** explored citizen sensing in the framework of socio-legal reflections on the Anthropocene, demonstrating the potential of 'monitoring citizens' to claim agency and play a pivotal role in steering environmental policies, decision making and — eventually — justice. **Emu-Felicitas Ostermann-Miyashita** presented a study, which has reviewed citizen science projects in the field of human-wild- life conflict to examine how citizen science can contribute to a better human-wildlife coexistence. The results demonstrate that citizen science is an effective tool for gathering wildlife data, and at the same time empowers citizens to participate in or drive (in a bottom-up manner) wildlife research and management.

At least, the SDGs are often criticised for excluding certain perspectives and topics, such as biocultural diversity, which encompasses biodiversity, cultural diversity and linguistic diversity and their interrelations. **Barbara Heinisch** exemplified how humanity can contribute to these questions: in order to study, understand and preserve biocultural diversity, the (citizen) sciences and the (citizen) humanities must continue and deepen their collaborations.

WEOBSERVE

Gerid Hager, Novel Data Ecosystems for Sustainability Group (NODES), Advancing Systems Analysis Program (ASA), International Institute for Applied Systems Analysis

The WeObserve project — an H2020 Coordination and Support Action — organised a full conference session thread with four consecutive sessions, aiming to promote Citizen Observatories as integral to environmental monitoring at a European and international level and sharing experiences and knowledge gained in WeObserve. The sessions involved interactive formats and were targeted at Citizen Observatories and community-based initiatives, citizen science practitioners, researchers, policy and decision makers, European Commission officers, UN agency representatives and data communities. With more than 200 participants on the day, the sessions were very well attended and highlighted the interest in the multiple dimensions addressed by WeObserve. While each session featured its own coherent perspective and discussion (see individual session insights), the overarching session thread offered a comprehensive view and coherent storyline on the landscape of Citizen Observatories and the potential they hold in the context of the 2030 Agenda and the Sustainable Development Goals. One important insight was that grasping the concept of Citizen Observatories on different levels and understanding the entirety of what Citizen Observatories are and what they can deliver requires the integration of many different perspectives. The first session provided insights from five specific Citizen Observatories to illustrate the diversity of topics, tools and approaches taken. It also highlighted open data, open-source tools and data interoperability as overarching topics and challenges that Citizen Observatories share in the pursuit of supporting sustainable development. Moving from a broad view to a more specialised session, the second session focussed on the efforts of the WeObserve SDG Community of Practice to link citizen science initiatives with the official SDG monitoring framework, from data and indicator mapping, to developing important international networks of practitioners, data communities, National Statistics Offices and UN agencies, to kickstarting pilot projects in Ghana to demonstrate the feasibility of integrating citizen science approaches with official monitoring. The third session expanded the view once more to discuss the broader social transformation potential of Citizen Observatories and highlighted the role of funders and funding schemes as enabling factors. The final session extended to the effects of Citizen Observatory outputs in other domains and sectors. It provided demos

and presentations of examples for the uptake of Citizen Observatory data highlighting how these data can inform and spur innovations for the pursuit of sustainable development in adjacent fields, such as Earth Observation, Open Science or AI for dynamic modelling.

1. CITIZEN OBSERVATORIES: THE LANDSCAPE, TOOLS AND DATA INNOVATIONS FOR SUSTAINABLE DEVELOPMENT

SESSION CHAIR
Valantis Tsiakos, Institute of Communication & Computer Systems (ICCS), Greece

SPEAKERS
Inian Moorthy, International Institute for Applied Systems Analysis, Austria | **Valantis Tsiakos**, Institute of Communication and Computer Systems, Greece | **Joan Masó**, CREAF, Spain| **Mel Woods**, University of Dundee, United Kingdom | **Saskia Coulson**, University of Dundee, United Kingdom | **Núria Castell**, NILU-Norwegian Institute for Air Research, Norway| **Louise Francis**, Mapping for Change CIC, United Kingdom | **Sven Manske**, RIAS e.V. - Rhine-Ruhr Institute for Applied System-Innovation, Germany

This session invited contributions from Citizen Observatories (COs) and projects to showcase CO tools and innovations that support sustainable development. It provided an overview of the current landscape of COs and presented innovations, such as new methodologies and conceptual models, as well as data innovations from hackathons, innovation and open data challenges.

Inian Moorthy presented the Horizon 2020 project, LandSense, which is a modern citizen observatory for Land Use & Land Cover (LULC) monitoring, that connects citizens with Earth Observation (EO) data to transform current approaches to environmental decision making. Citizen Observatories are community-driven mechanisms to complement existing environmental monitoring systems, allowing citizens to not only play a key role in LULC monitoring, but also to be directly involved in the co-creation of such solutions. Such initiatives present opportunities to integrate citizen-driven observations with established authoritative data sources, and support comprehensive environmental monitoring systems. These applications have considerable potential in lowering

expenditure costs on in-situ data collection and current validation approaches within the processing chain of environmental monitoring activities within and beyond Europe.

The H2020 SCENT project has created a toolbox of smart technologies and applications that aims to enable citizens to monitor Land Cover/Use (LC/LU) changes and how these affect flood phenomena in their urban or rural areas. **Valantis Tsiakos** highlighted the overall ability of the SCENT toolbox to improve flood models to be used for policy making with the citizen-science data collected. Results generated by the flood models can be used to design river interference measures that respect sustainable river basin development (SDG 11), to simulate climate change impacts on local flooding (SDG 13) and to help manage the health of aquatic ecosystems (SDG 14). More specifically, citizen-generated LC/LU information along with satellite images are used to train and properly configure the state-of-the-art deep neural network models allowing the production of improved semantically meaningful raster LC maps. Monitoring land cover and land use change is important for land resource mapping, understanding ecosystem services including resilience to climate change, natural disasters and biodiversity conservation.

Imagine a world where 503 environmental science projects collect data in 503 independent silos with no easy method of connecting the data together. This is what a recent study from the JRC has found. Combining data from more than one project will provide a challenge due to different formats and concepts behind the data. In 2019, the WeObserve Interoperability Community of Practice organised a Citizen Science Interoperability Experiment (IE). The IE demonstrated approaches on using clients and services implementing OGC Sensor Observing Service. The final aim was to propose solutions on how citizen science data could be integrated in the Global Earth Observation System of Systems (GEOSS). The application of international geospatial standards in current citizen science projects to improve interoperability is one of the main tasks. **Joan Masó** extended the demonstrations to cover potential solutions for connecting CO data with other data sources and lighter protocols such as the OGC SensorThings API.

Mel Woods introduced the Open Data Challenge (ODC), a competitive online event designed to support data innovation for critical environmental issues. Furthermore, the ODC team identified opportunities for network building with participants to existing projects. In order to support the challenge, four COs made their datasets publicly

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available for the first time. These datasets were framed by seven social and environmental themes as innovation challenges. These included: ecosystem monitoring, public infrastructure management, community-based disaster management, regenerative food growing, pollution monitoring and health, and engaging young people. The ODC had a number of aims to overcome these challenges: amplifying the innovation potential of data, supporting the development of prototypes through an award of a tender, engaging a global community with open environmental datasets, and raising awareness of the environmental issues at stake.

Saskia Coulson presented a contextual review of existing resources which identifies a gap in the provision of open-source, accessible and collaborative tools for citizen science and citizen observatories. There is a lack of tangible and adaptable resources, which is something that hampers the acceptance of citizen science practices for tackling global challenges. Coulson presented a categorisation of four crucial areas where there are minimal tools that support engagement efforts, namely: i) Co-Designing a Citizen Observatory, ii) Data Capture for Environmental Monitoring, iii) Data Quality and Visualisation, and iv) Evaluation and Advocacy. The discussion signposted to the growing number of platforms which aim at providing repositories and considers the potential of these burgeoning initiatives, e.g., levels of facilitation required, specific competencies for use, and barriers to resource sharing and toolkit interoperability. Coulsen presented some of the existing tools and toolkits which seek to address the above areas gathered from a range of projects using participatory approaches. She concluded with recommendations for future practice, best practice for design of resources, and the value of open-source tools and toolkits in the field of citizen science.

NordicPATH is a research and innovation project whose overall objective is to establish a new model for citizens' participation and collaborative planning in the Nordic countries focussed on urban air quality and the interlinked challenge of climate change. **Núria Castell** focussed on strategies to engage citizens in the process of socio-technological change required by planners and designers to provide the built environment and the services that will shape future sustainable cities with a human-centred approach. NordicPATH will investigate how technologies can facilitate processes of collaborative co-design of solutions towards shaping more liveable, healthy and sustainable cities for everyone. The main research question is whether bottom-up processes can be

concretely combined with urban planning practices and policy processes in relation to important environmental issues. The project aims to contribute to the integration of different dimensions of urban sustainability and resilience in the framework of the UN Sustainable Development Goals. In particular, it contributes to Goal 11 in making cities inclusive, safe, resilient and sustainable; to Goal 3 creating healthy environments and promoting well-being for all at all ages and to Goal 4 equipping locals with the tools required to develop innovative solutions to the world's greatest problems.

Odour represents a significant proportion of citizens' environmental complaints across Europe. Frequent exposure to odours can affect people's health, wellbeing and quality of life (SDG3). Odour can also indicate environmental issues, e.g., poor waste management, wastewater leakages and air pollution. However, odour pollution is largely ignored in policy agendas, leaving citizens without recourse and regulators with little power. This can lead to socio-environmental conflicts within impacted communities. D-NOSES (Distributed Network for Odour Sensing, Empowerment and Sustainability) is an EU H2020 project that aims to build a multi-level governance model for increasing sustainability in communities suffering from odour pollution. It combines participatory tools and an informative website to appeal to all stakeholders: citizens, industry, researchers and policymakers. **Louise Francis** demonstrated participatory tools including OdourCollect, an App to collect citizens' real-time odour observations and Community Maps. Their use includes addressing challenges related to air quality, food insecurity, climate resilience and agricultural practices, biodiversity monitoring and illegal logging.

While the body of knowledge about WHAT is learned through participation in online Citizen Science projects has expanded over the past years (Aristeidou & Herodotou, 2020), the research field also shifts focus to better understand HOW task-sharing and learning happen in Citizen Science (CS). Technology-enhanced and online citizen science projects allow for analytical tools to be applied directly to digital traces (e.g., Herodotou et al. 2020, August et al., 2020). For example, increasing individual centrality values over time indicate a growing influence of a participant and enable us to map individual learning trajectories. In the context of the EU project CS Track, we have applied this methodology to the popular Zooniverse project Chimp&See, which is based on the analysis of wildlife camera recordings especially of chimpanzees across Africa. The project has an explicit

conservation goal (SDG 15 - Life on land) and has involved more than 5500 volunteers. **Sven Manske** and his team analysed the communication between volunteers, scientists and moderators in the public discussion forum using techniques of social network analysis. The findings show that moderators play a crucial role in mediating and coordinating citizen science activities. Manske emphasised the potential of network analysis methods to help in the design, facilitation and assessment of participation, decision-making and knowledge-building in such online communities. This has the potential to support CS projects in contributing to quality education (SDG 4) and possibly even gender equality (SDG 5) in science education and participation in science.

2. CONTRIBUTION OF CITIZEN SCIENCE DATA TO MONITORING THE SDGS

SESSION CHAIR
Dilek Fraisl, International Institute for Applied Systems Analysis (IIASA), Research Scholar at the Center for Earth Observation & Citizen Science, Austria

SPEAKERS
Steffen Fritz, International Institute for Applied Systems Analysis (IIASA), Austria | **Jillian Campbell**, UN Convention on Biological Diversity, Canada | **Camden Howitt**, Sustainable Coastlines, Co-Founder and Coastlines Lead, New Zealand | **Anne Bowser**, Woodrow Wilson International Center for Scholars, United States | **Omar Seidu**, Ghana Statistical Service, Ghana

Citizen science offers a great potential to monitor progress of the SDGs and complement traditional sources of data such as censuses and household surveys. In fact, ❯ a recent publication by Fraisl et al. highlights that citizen science data are already informing or could inform 33% of the SDG indicators. The greatest potential from citizen science to the global SDG indicator framework would potentially be in environmental SDG indicators, 68% of which currently lack data, according to ❯ UNEP (2019). In order to realise the untapped potential of citizen science for SDG monitoring, it's important to develop awareness within the citizen science, data and statistics communities with respect to the use of citizen science approaches regarding the SDGs and work with the key stakeholders early in the design phase of an initiative. These key stakeholders would include citizen science practitioners and researchers, National Statistical Offices (NSOs) or

other government officials, the UN custodian agency representatives and Civil Society Organisations (CSOs), among others. An enabling environment that facilitates the dialogue between these stakeholders around data is the key to success for leveraging citizen science for the SDGs. The enabling environment also requires effective and supportive legal frameworks, financial means and capacity development. A legal infrastructure could be useful to realize the potential offered by citizen science and other new sources of data for the SDGs. This could include a recognised body, with the authority and competence to certify statistics as fit for purpose ❯ (McFeely & Nastav, 2019). The WeObserve SDGs and Citizen Science Community of Practice (SDGs CoP), established as part of the H2020-funded WeObserve project, connects these aforementioned key stakeholders to identify and demonstrate the value of citizen science data for SDG monitoring and implementation, and support mechanisms that fosters this enabling environment. Finally, citizen science could help in raising awareness on and mobilising action for the SDGs, while at the same time addressing the aforementioned SDG data gaps and needs, which is key to achieving the global goals.

3. TRANSFORMATIVE POTENTIAL OF CITIZEN SCIENCE AND CITIZEN OBSERVATORIES FOR MOBILISING ACTION TOWARDS ACHIEVING THE SDGS

SESSION CHAIR
Uta Wehn, IHE Delft Institute for Water Education, Netherlands

SPEAKERS
Valantis Tsiakos, Institute of Communication & Computer Systems (ICCS), Greece | **Mel Woods**, University of Dundee, United Kingdom | **Michele Ferri**, Alto Adriatico Water Authority, Italy | **Steffen Fritz**, International Institute for Applied Systems Analysis (IIASA), Austria | **Stijn Vranckx**, VITO, Belgium

This session addressed the transformative potential of citizen science and citizen observatories (COs) towards the SDG agenda more broadly, including the creation of capacity and community for change, triggering behaviour change as well as supporting disaster management and emergency response. It highlighted that achieving the SDGs requires behaviour change of individuals as well as

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organisations on unprecedented scales and that CS and COs can constitute integral policy measures (for specific SDGs) and not just 'mere' instruments for monitoring policy attainment. Five speed talks presented brief illustrations of how recent citizen observatories have served to trigger individual behaviour change and/or organisational change at different governance levels. The session outcomes stress that, apart from the stakeholders already involved in COs, we need to reach out to others to trigger broader changes, especially communities not related to science and environmental issues. While in general, stakeholder openness and willingness was considered to be dependent upon the specific settings, key success factors consist of facilitating engagement in the early stage, allowing groups to propose the challenges for action. Strong arguments were made to the effect that initiatives must come from the side of the authorities in order to ensure higher probability of success. There was general agreement that openness of data is a precondition for many citizens and communities, most of whom prefer to own their own data, hence determining their willingness to collaborate in citizen science and Citizen Observatories. Sensitising the general public and public authorities to the enormous potential of CS was seen to proceed via the route of 'data value added': a virtuous cycle from CS initiatives in which public authorities recognise the value of this new data stream, the opportunity to improve models and processes, resulting in policy action and convincing more authorities. At the same time, it is important to support the process of helping stakeholders understand each other's perspective (e.g., communities and authorities). Overall, the 'power of examples' was stressed in order to illustrate how CS and COs can trigger long term changes, to extract lessons across CS projects in terms of efforts to truly achieve the SDGs, and to understand the dynamics and changes that need to be achieved in terms of transforming entire systems.

4. WEOBSERVE SHOWCASE: DEMON-STRATING VALUE AND APPLICATIONS OF CITIZEN OBSERVATORY DATA

SESSION CHAIR
Valantis Tsiakos, Institute of Communication and Computer Systems, Greece

SPEAKERS
Turam Purty, Citizen Science Earth, United States
Gulsen Otcu; HITSOFT, Turkey | **Valantis Tsiakos**, Institute of Communication and Computer Systems, Greece

Turam Purty introduced the open-source tool CitSci Manager that helps citizen science researchers, enthusiasts and volunteers save valuable time in exploring open datasets spread across a variety of data formats. The tool enables users to freely access metadata headers and sample datasets from a diverse set of projects and generate custom files for research and analysis. Opening up samples of data in such a manner allows citizen science researchers, volunteers and other open data enthusiasts in the community to accelerate collaborations in environment and climate change research.

Hi-Terra is designed as a platform which will perform data processing to generate fore-casts of soil moisture and watering. Since it has a dynamically learning capacity, the model is able to improve the forecast performance and to iteratively advance itself by using more data sets. It constitutes a sensitive, intelligent and reliable platform for producing forecasts for users, both to gain insights about soil moisture, watering time, amount of watering as well as being notified about severe weather conditions, irrigation needs or water level anomalies. **Gulsen Otcu** emphasised that Hi-Terra provides resource efficient, cost effective and easy-to-use solutions while taking its unique characteristic from the deep learning algorithms in its core. Hi-Terra, as an infrastructure, has a capability to be used within a wide spectrum of application areas from personal landscapes (gardens, yards), greenhouses, fields to golf courses, greens.

WeObserve has introduced and organised three citizen science challenges in the context of the Dubrovnik INSPIRE Hackathon. The goal of these challenges is to improve interoperability between Citizen Observatories and existing citizen science community activities while also making a whole range of citizen science sources, data, and information both discoverable and accessible, along with other sources, such as Copernicus and GEOSS. In particular, the following aspects were investigated and addressed from the participants in the challenges: I.: Realisation of techniques to enhance geo-spatial and/ or INSPIRE enabled web-based or mobile applications so as to connect to either Citizen Science and/or Earth Observation data. Particular focus was given on improving accessibility to protected citizen science resources while also enabling their direct consumption and utilisation by third party applications. II.: Implementation of data harvesters so as to enable integration of datasets provided from Citizen Observatories, with a central catalogue, as an approach to connect citizen science into GEOSS.iii.: Making available datasets provided by H2020 Citizen

Observatories as well as by other citizen science projects and initiatives, through the use of OGC SensorThings API standard and mapping of data coming from different sources. This involves also sharing of environmental measurements coming from different IoT devices and in-situ monitoring sensor networks, aiming to establish combined use of data and services among different platforms towards improved environmental monitoring.

Traditional environmental monitoring systems such as Copernicus, produces a variety of valuable datasets relevant to environmental monitoring (i.e. land cover/use, atmospheric emissions, ocean water quality, etc.). This data is meticulous and offered for the entire EU landscape, however its update rate is scarce due to increased costs and timely data validation procedures. Citizens' observations, data and information can complement these official, traditional in-situ and remote sensing data sources, allowing relevant authorities to improve and fill gaps in the environmental monitoring process. Two interactive events (workshop and webinar) were organised by the H2020 WeObserve project, aiming to present success stories where citizen science data are combined with conventional sources of Earth Observation data. Best practices arising from the activities of H2020 Citizen Observatories (LandSense, GROW, GroundTruth 2.0, SCENT) were presented, including other projects as well, while illustrating how the integration of Earth Observation and citizen science can improve environmental monitoring.

PARTICIPATORY CITIZEN SOCIAL SCIENCES TOWARDS THE SDGs

SESSION CHAIRS
Stefan Thomas, University of Applied Sciences Potsdam, Germany | **David Scheller**, University of Applied Sciences Potsdam, Germany

SPEAKERS
Francesco Mureddu, Lisbon Council, Belgium | **Emilia Aiello**, Harvard Kennedy School, United States | **Margarida Romero**, Laboratoire d'Innovation et Numérique pour l'Education. Université de Nice Sophia Antipolis, France

In the session "Participatory Citizen Social Science towards the SDGs" chaired by **Stefan Thomas** und **David Scheller**, challenges of citizen science in the context of social research projects about SDGs have been discussed. Citizen social science (CSS) is an invitation to citizens to engage as

co-researchers in collaborative research on social issues. In particular, the panel focussed on the possibilities, necessities and boundaries of broad participation and collaboration in the research and innovation cycle, which was reflected from different angles in the paper presentations.

Francesco Mureddu highlighted in his paper on "Stakeholder engagement methodologies and practices for citizen (social) science" especially the engagement of marginal groups based on experiences from the "REINFORCE project" (Research Infrastructures FOR Citizens in Europe).

Margarida Romero and **Maher Slouma** discussed in their paper "Addressing the Sustainable Development Goals through the design of digital games by middle school, high school and apprentices" how a better understanding of SDGs, an improvement of self-efficacy and transformative agency among co-researchers was achieved, which eventually had a positive effect on decision-makers to take action.

In their paper "Towards a transformative Citizen Social Sciences for the accomplishment of the SDGs" **Emilia Aiello**, **Teresa Sorde-Marti** and **Ana Burgués de Freitas** argued for a radical shift in scientific knowledge production for progressing with SDGs, which requires an interdisciplinary approach, flat hierarchies in the research teams, and the inclusion of hard-to-reach grassroots groups.

Stefan Thomas and **David Scheller** proposed and discussed "Seven Principles for a Citizen Social Science" that highlight specifics of social science in addition to the general 10 Principles of Citizen Science and emphasised in particular the extension of participation and collaborative reflection regarding research topics with immediately relevance for citizens' everyday life through ongoing exchange in the "Research Forum".

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Sessions

Theme 3
—
Policies, platforms and networks to achieve the SDGs

project timelines versus the manifestation of longer-term impacts; data collection issues; project priorities; lack of expertise; and the lack of capacity — all that vary, depending on the SDGs involved.

Finally, the session examined how artificial intelligence can enhance citizen science projects involving non-traditional data sources such as social media, in order to provide effective monitoring of SDG indicators by citizens, and to stimulate grassroots innovation for tackling the SDGs.

CITIZEN SCIENCE PLATFORMS AS A WAY TO IMPACT ON THE SDGS

SESSION CHAIR
Colombe Warin, European Commission

KEYNOTE
François Grey, University of Geneva, Switzerland

SPEAKERS
James Sprinks, Earthwatch, United Kingdom | **Susanne Hecker**, Museum für Naturkunde Berlin, Germany **Patricia Santos**, Universitat Pompeu Fabra, Spain

This session focussed on the importance of sharing knowledge, training materials and resources about citizen science, taking stock of the experiences of national and European platforms as a way of working towards SDGs. It was stressed that, with the COVID-19 crisis and the lockdown, all over the world, there were growing online activities. This has resulted in a boost for citizen science by opening and making it more widely available as citizen science activities moved online. Taking into account the difference in time zones to find a common slot was sometimes less challenging than gathering citizens in a physical location.

Online platforms are also used as a hub to gather information and toolkit at national level, as is the case in Germany. The German networking platform, created in 2014, gathers 145 citizen science projects active covering many different SDGs, such as water, on climate change, water or sustainable cities.

At the European level, innovative projects, such as MICS or CS-Track, both supported by Horizon 2020, are building impact assessment methodologies by a combination of data collection methods and datasets. Challenges do exist however, relating to the definition of impact; funding and

WHO IS ENGAGED IN CITIZEN SCIENCE — AND WHO COULD OR SHOULD BE?

SESSION CHAIR
Jens Jetzkowitz, Museum für Naturkunde Berlin, Germany

KEYNOTES
Philipp Schrögel, Karlsruher Institut für Technologie, Germany | **Claudia Göbel,** Institut für Hochschulforschung (HoF) an der Martin-Luther-Universität Halle-Wittenberg, Germany

SPEAKERS
Rachel Pateman, University of York, United Kingdom **Christine Urban**, Wissenschaftsladen Wien — Science Shop Vienna, Austria | **Stefan Reichmann**, TU Graz - Graz University of Technology, Austria

Various parts of society are not reached by the established forms of science communication, public engagement or citizen science alike. The challenge for equitable participation is increasingly addressed in research and practice. **Philipp Schrögel** gave a comprehensive overview of underserved audiences and broader empirical evidence, which is lacking so far. Practical approaches and theoretical works often focus on certain aspects or areas of exclusion. Furthermore, the heterogeneity of the underserved audiences makes it difficult to define concrete groups that are left out or discriminated against. The keynote talk gave an overview on current studies addressing the audiences of science engagement and introduced a typology of exclusion factors developed in the project "science for all" as well as present some theoretical thoughts on the inclusive shaping of participation, engagement and openness.

Diverse communities of practice are key to generate knowledge for change — as truly innovative and

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transformative Citizen science. **Claudia Göbel's** contribution examined structural influences on participation. What role do research organisations, citizen science networks and the design of policies have for inclusion and exclusion? Göbel presented reflections from her practical work and research with the European citizen science Association, where she co-leads the working group on equity and inclusion. Key factors for improving inclusiveness in citizen science on an infrastructural level are the involvement of civil society organisations in citizen science activities, inclusive events and spaces of exchange between neighbouring communities of practice.

Urban environments in low and middle income countries present increased environmental and social challenges, including from the impacts of unplanned development. The SDGs include, for the first time, a goal focussed on cities, as well as numerous other goals relevant to urban environments, such as those focusing on poverty, health, and access to water and sanitation services. Rachel Pateman progress towards achieving the SDGs is monitored with a set of targets and indicators. Gaps in official datasets used for monitoring have led to calls for the inclusion of non-traditional data sources, including data generated through citizen science and allied approaches. Co-benefits of citizen science for participants, partnership building and decision making at a range of scales, mean these approaches can also be a means of achieving the SDGs. The SDGs aim to "leave no one behind", yet who is participating in these projects and, therefore, who is receiving the benefits, how representative are the data collected and how inclusive is subsequent decision-making? Used information from a systematic review of the academic and grey literature which identified projects collecting and using citizen-generated data in urban environments in low- and middle-income countries. Pateman explored the countries projects are taking place in and, within these projects, who is participating. They discussed the potential impacts on biases in participation for the objectives of these projects (e.g., in monitoring environments or informing urban planning) and supplemented this information with findings from interviews with citizen science project leaders to explore the challenges related to engaging participants.

Involving the public and stakeholders in research or science policy is nothing new. Mainly due to modern ICT, we have seen new forms of public engagement in the sciences in the past 20 years. The normative claim that involving citizens in scientific research democratises the sciences is relatively new. Science shops, community-based research

practitioners, and others made, respectively make, this claim, with citizen science associations being the most recent ones. **Christine Urban** emphasized that involving citizens in research is beneficial for all participants and the sciences and society at large. There is meagre empirical evidence of the impact citizen science projects and public engagement in the sciences in general have (for exceptions see Dosemagen et al. 2019, Tang et al. 2019 et. al.). The Horizon 2020 project "Expanding our knowledge on Citizen Science through analytics and analysis" (CS Track) aims at narrowing this knowledge gap by investigating citizen science projects in respect to enablers and barriers these projects face, tasks conducted by volunteers and professional scientists, costs and benefits, ethical and integrity issues in citizen science, and the way in which participants collaborate, among other aspects.

Socially inclusive forms of knowledge production form a core element of Open Science. Open Science continues a long-standing agenda of participatory research to suggest that participation in research fosters democratisation. **Stefan Reichmann** highlighted that civil society actors and other societal stakeholders not only benefit from open access to scientific outputs but also, crucially, represent resourceful contributors to processes of knowledge production. Therefore, citizen science furthers public engagement throughout scientific knowledge production. Citizen science could also facilitate dialogue between science and society. However, some argue that all citizen science does is entice non-scientists to perform remote data processing labour under the guise of purported democratisation of science. Instead of contributing towards equity, responsible research practices might worsen existing inequalities. The contribution of citizen scientists builds on Merton's (1968) idea of the Matthew effect, a dynamic of cumulative advantage where already powerful individuals/institutions accrue a disproportionate amount of rewards. Since then, studies have identified many ways in which effects of cumulative advantage in research play out at the level of article citations, journals, institutions, departments, and countries, as well as the individual attributes of researchers. These effects operate across a range of scientific activities, including peer review, funding acquisition, and public engagement. Matthew Effects might be at play in the (self)selection of citizen scientists.

OPENING SOCIAL SCIENCE & HUMANITIES RESEARCH TOWARDS SOCIETY: REQUIRED INSTITUTIONAL SETTINGS

SESSION CHAIRS
Claudia Göbel, Institute of Higher Education Research at the University of Halle-Wittenberg, Germany | **Justus Henke**, Institute of Higher Education Research at the University of Halle-Wittenberg, Germany | **Susann Hippler**, Institute of Higher Education Research at the University of Halle-Wittenberg, Germany

KEYNOTE
Claudia Göbel and **Justus Henke**, Institute of Higher Education Research at the University of Halle-Wittenberg, Germany

SPEAKERS
Alexandra Albert, University College London, United Kingdom | **Anna Cigarini**, OpenSystems Research Group - Universitat de Barcelona, UBICS, Universitat Oberta de Catalunya (IN3), Spain

How does the landscape of Citizen Social Science (CSS) activities in Germany look like and what can we learn from it? The session presented results of the 2-year research project "Social Citizen Science for Addressing Grand Challenges (SoCiS)" as a starting point for discussion with practitioners. The overall focus was on cooperation in CSS activities. Next to cooperation between volunteers and professional researchers, cooperation in heterogeneous projects of academic and non-academic partners is a central yet under-researched feature of CSS. Typical non-academic partners include civil society organisations, administrations or schools. On these grounds, we introduced the concept of "cooperation capacity" to capture this key success factor of CSS activities. Instead

of focussing merely on participation capacity and asking "What do volunteers need to know or learn to participate in scientific projects?", the question transforms into "How to make cooperation between heterogeneous partners work?". The subsequent discussion with **Alexandra Albert** (UCL London, Project Act Early) and **Anna Cigarini** (Uni Barcelona, Project CoAct for Mental Health) explored how CSS projects address different dimensions of cooperation capacity in practice. The latter included, for instance, using heterogeneous forms of expertise or necessary adaptations in research funding structures.

More information on the SoCiS project can be found here (in English): ❯ https://www.hof.uni-halle.de/project-socis/

The detailed research report, an illustrated practice guideline and an Open Educational Resource can be found here (in Germany): ❯ https://www.hof.uni-halle.de/projekte/socis/

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CITIZEN SCIENCE IS SOCIAL! EVENING EVENT WITH HANDS-ON CITIZEN SOCIAL SCIENCE

CHAIRS
Claudia Göbel, Institute of Higher Education Research at the University of Halle-Wittenberg, Germany | **Josep Perelló,** Universitat de Barcelona, Spain

CONTRIBUTORS
Andrea-Isermann Kühn, NGO DorfwerkStadt, Germany **Eleonore Harmel**, Thünen Institute, Germany | **Franziska Peter,** Universitat de Barcelona, Spain | **Guillermina Actis**, University San Martín, Argentina | **Justus Henke**, Institute of Higher Education Research (HoF) Halle-Wittenberg, Germany | **Magdalena Meißner**, Technical University Berlin, Germany | **Mariam Malik**, University of Vienna, Austria | **Nicola Gabriel**, Institute of Higher Education Research (HoF) Halle-Wittenberg, Germany | **Pia Marchegiani**, Environmental and Natural Resources Foundation (FARN), Argentina | **Rainer Leppin**, DorfwerkStadt, Germany | **Reidun Norvoll**, Oslo Metropolitan University, Norway | **Stefan Thomas**, University of Applied Sciences Potsdam, Germany **Susann Hippler**, Institute of Higher Education Research (HoF) Halle-Wittenberg, Germany | **Teresa Wintersteller**, University of Vienna, Austria | **Valeria Arza**, University San Martín, Argentina

Social research plays an increasingly important role in citizen science and transformative social change becomes an essential dimension of impact. It is therefore time to talk about citizen SOCIAL science! The aim of the evening event was to make the diversity of Citizen Social Science (CSS) and their contributions to future challenges visible. Two alternative conceptions of what constitutes "the social" in CSS served as a starting point. On the one hand,

the SoCiS project considers CSS to be scientific research in the field of humanities and social sciences in cooperation with non-professional scientists, i.e. the social comes into play via the scientific discipline. On the other hand, the CoAct project defines CSS as participatory research co-designed and driven by citizen groups sharing a social concern, as Co-Researchers. CSS methods aim to give an equal 'seat at the table' through active participation in research and their transformation into concrete actions.

A short video, compiling several individuals' and projects' views on CSS, provided a vivid insight into the diversity of CSS activities. This video summarised the results of an open call "Citizen Science is Social!" where projects, especially civil society organisations, were invited to briefly present their work and their view of the special features of CSS. After this introduction, four workshops invited conference participants to experience CSS first hand and to discuss with practitioners. On the basis of concrete project experiences, links to sustainable development were outlined and discussed.

The first workshop explored the role of inclusiveness, who can participate and who remains excluded, of CSS activities for sustainability transformations. **Magdalena Meißner** shared experiences from her co-research on sustainable consumption in the „Repara/kul/tur" project and **Reidun Norvoll** presented her plans for the EU project "YouCount" on inclusion of disadvantaged youth. Contributions of CSS to sustainable living in cities and villages were explored in the the second workshop: One is research in a living lab for urban development by **Andrea-Isermann Kühn** and **Rainer Leppin** run by DorfwerkStadt, another one is co-creating new types of data for planning in rural areas in **Eleonore Harmel's** project "Landinventur". The third workshop focussed on the joint design of online platforms for CSS on mental health care and environmental justice issues. **Franziska Peter** and **Josep Perelló** presented the co-creation of a chatbot for investigating social support networks in mental health care. **Valeria Arza**, **Guillermina Actis** and **Pia Marchegiani** shared lessons from their work on environmental justice in a heavily contaminated 64 km long river that runs along the southern peripheries of the city of Buenos Aires. In the fourth workshop, **Mariam Malik** and **Teresa Wintersteller** focussed on challenges of participatory research methods using life-world experiences and provided several strategies to further self-reflect on them.

The final discussion gave space for participants to reflect their impressions from the workshops and overarching

questions about CSS. Overall, Citizen Social Science represents a growing, diverse and dynamic area of activity. It harbours important contributions to sustainability in general and the SDGs in particular. Through their focus on issues from humanities or social sciences and citizen groups as well as their methodological sophistication, the various research and engagement traditions that CSS unites offer a rich reservoir of practices to engage in.

The evening event was co-organised as partner event by the SoCiS project (funded by the German Federal Ministry of Education and Research -BMBF- Förderkennzeichen 16ITA210) and CoAct project (funded by the European Union's Horizon 2020 research and innovation programme under grant agreement number 873048).

PARTNERSHIPS TOWARDS THE GOALS — MAKING SUSTAINABLE CHANGE SUSTAINABLE WITH CITIZEN SCIENCE

SESSION CHAIRS
Jörn Knobloch, Museum für Naturkunde Berlin, Germany **Claudia Fabó Cartas**, Museum für Naturkunde Berlin, Germany

SPEAKERS
Nicola Moczek, Museum für Naturkunde Berlin, Germany | **Jan-Philipp Beck**, EIT Health, Germany | **Macarena Cardenas**, Earthwatch Europe, United Kingdom | **Kim De Rijck** and **Sven Schade**, Tilburg University & The European Commission Joint Research Research Center, Italy | **Maria Vicente**, Plataforma de Ciência Aberta — Municipality of Figueira de Castelo Rodrigo, Portugal; University of Leiden, Netherlands

In order to make sustainable change in society truly sustainable, a combination of scientific knowledge and social participation or cooperation is required. Therefore, the conference presented citizen science as a best-practice solution, which — given its specific character as a mode of social self-enlightenment — has the potential to broadly anchor the knowledge needed for a societal change and increase the public support of social transformation. However, a shared framework for equal cooperation is required to secure this knowledge long term, which has to be developed — this is what we refer to as partnerships for change. The participants of this session discussed the conditions and forms of such partnerships. **Nicola Moczek** started the discussion with the presentation of the results

of a survey, which asked citizen science projects about their contribution to the SDGs. The results of the survey demonstrated that while surveyed projects contribute to all SDGs the infrastructure and institutional support to facilitate data sharing is lacking, thus encouraging the development of partnerships. Then, **Jan-Philip Beck** from EIT Health presented the health partnership model as an innovative solution towards addressing the societal health challenge. This partnership model highlights the importance of involving people in what matters to and affects them and is EIT Health's strategy to involve citizens in health innovation towards delivering societal impact. This underlines the role of citizens and patients as a central element of all partnerships. The next presentation from **Macarena Cardenas** (Earthwatch Europe) gave an example of a partnership for the creation of sustainable cities. The contribution from **Kim De Rijck** (DG Environment) and **Sven Schade** (JRC) introduced a best-practice approach for a partnership with citizen science for environmental monitoring. In the end, **Maria Vicente**, scientific coordinator of the Plataforma de Ciência Aberta, presented general experiences from the project "Drinkable Rivers", which involved the local community through citizen science in monitoring water quality of the Douro River. The presentation and the subsequent discussion facilitated the revelation of valuable aspects of the partnership. The good examples of sustainable urban reconstruction, environmental monitoring as well as the collective search for higher water quality highlighted the exclusive state of citizens to collect local knowledge. The address of the partnerships for change is uncontroversial: the citizens and their unique position of collecting and applying local as well as practical knowledge. What's still lacking and what the discussion has not yet been able to clarify conclusively is a general model of the partnership for change. However, the session revealed some general components.

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Declaration
—
Background and objectives

One of the main conference outcomes was to formulate a Declaration including policy recommendations as a voluntary commitment by citizen scientists, academics and policymakers to define the roles, competences and concrete potentials of citizen science to advance the SDGs and focussed on the future of citizen science and its implementation in future funding programmes. The Declaration titled "Our world – our goals: citizen science for the Sustainable Development Goals" was formulated in an open, bottom-up participatory process involving the citizen science and SDG communities.

The Declaration is meant to acknowledge the diverse structure of citizen science. The unique characteristics of citizen science is a complex enterprise, because its social and scientific function cannot be achieved in any other way. Only citizen science simultaneously serves several types of logical practical approaches, since it mediates between science and society and functions to fill gaps. The main aim of the Declaration is the communication of the complexity and reliability of citizen science transparent for all.

Transparency and openness were the themes of the co-creation process of the Declaration. Aspiring to bring the citizen science and SDG communities together, the CS-SDG project team organised a series of five virtual meetings called "Become an author of the Declaration" during the summer 2020 organised and moderated by Jörn Knobloch from the CS-SDG project team at the Museum für Naturkunde Berlin and hosted by ECSA (European Citizen Science Association).

Meetings were held at midday (12:00 pm – 01:30 pm CET) in order to make participation from other time zones easier. Some virtual meetings included expert lectures that were

held by **Anne Kathrine Overgaard** and **Thomas Kaarsted**, **Alexander Gerber**, and **Dilek Fraisl**. After the expert lectures and/or introduction by the moderator, participants were divided into groups to discuss and simultaneously work on already prepared documents online.

The titles and summarised contents of the five virtual meetings are:

1. **Virtual meeting 1 – 1st July 2020: "Scoping aims and potential impacts"**
    Different options for a Conference Declaration were presented and discussed. Participants were able to actively contribute their ideas to the content of the Declaration.

2. **Virtual meeting 2 – 12th August 2020: "Declaring the Declaration"**
    The scope of the Declaration was at the centre of the discussion and collective answers to the following questions were found: What is the purpose of the Declaration? Who develops the Declaration? Who are the recipients of the Declaration? What are the goals of the Declaration?

3. **Virtual meeting 3 – 26th August 2020: "In pursuit of a meaningful statement"**
    We worked together on the precise formulation of our goals. Each working group focussed on a different part of the Declaration. In a common creative process, all participants contributed to the document with their specific perspective. A preliminary draft of the Declaration emerged from this meeting.

4. **Virtual meeting 4 – 2nd September 2020: "How can we implement our goals?"**
    The practical implementation of the goals, on which we agreed on in previous discussion was at the heart of the debate. Different ways to implement the goals were discussed and formulated in concrete terms.

CITIZEN SCIENCE SDG CONFERENCE
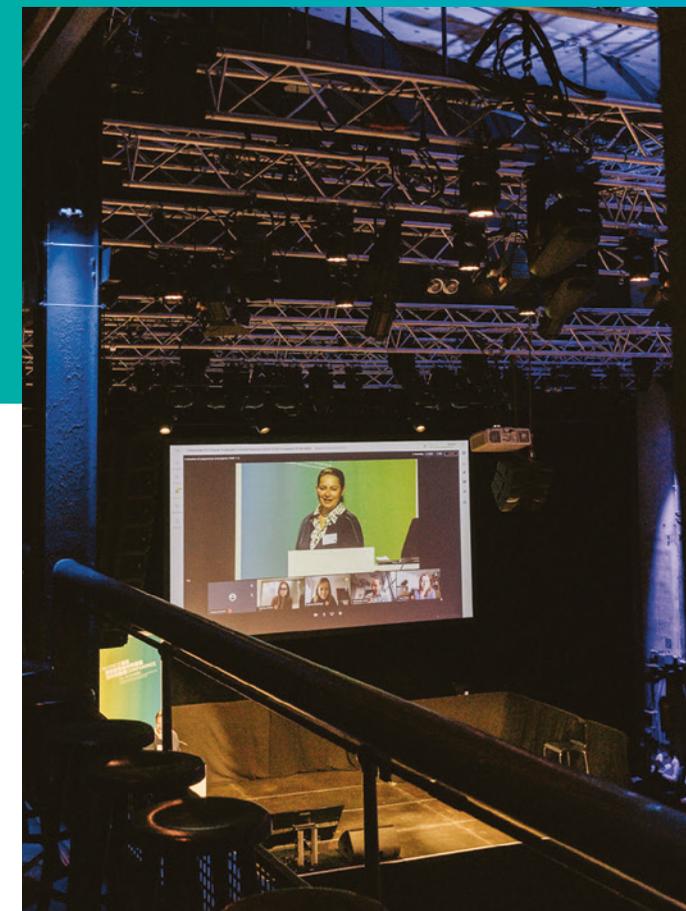
The Declaration
—

Our world — our goals: citizen science for the Sustainable Development Goals

We, the authors, call on European institutions, EU Member States and their research and innovation funding and performing organisations, private companies and civil society to make citizen science a key factor across all policies and activities relevant to the SDGs, including in shaping and implementing the European research agenda. In order to achieve these, we make the following recommendations.

RECOMMENDATIONS

1. HARNESS THE BENEFITS OF CITIZEN SCIENCE FOR THE SDGs

• Through citizen science, citizens must be supported and encouraged to generate new scientific knowledge to support the SDGs, in collaboration with policymakers, academia, research institutions, research funding agencies, researchers, citizens and civil society organisations and according to recognised and tested standards.

• Academia, universities and research institutes must be supported to restructure and open up to give space and opportunity for citizen involvement. Citizen science needs organisational forms to provide the approach with a route and framework and at the same time guarantee for quality.

• Policymakers and research funders should provide strategic and financial support to citizen science networks, capacity-building activities and initiatives, as well as to changes in research organisations, whilst also supporting the active engagement of EU citizens in implementing the SDGs.

2. STRENGTHEN CITIZEN SCIENCE AND ITS CONNECTIONS WITH OTHER COMMUNITIES

• Citizen science networks and communities must interact more closely with thematic research communities that produce scientific knowledge and technological innovation for the different SDGs, such as R&I for the environment, health R&I, food R&I, energy and transport R&I. Policies should be put in place to encourage and support citizen science networks and communities of practice focussed on sustainability to enhance networking with diverse stakeholders (e.g., research organisations, non-governmental organisations, civil society organisations, policymakers and private companies), and help to align citizen science activities with policy and research needs.

• To promote and create synergies, systems should be established to increase the coordination and exchange of citizen science information and tools relevant to the SDGs, across countries and at the global level, and across thematic areas.

• To ensure and increase the usability and acceptance of citizen science data and evidence in efforts to achieve the SDGs, citizen science communities should communicate transparently on the methodologies they use, potential bias in the data they generate, and their data quality management strategies.

• Authorities across Europe should further promote, encourage and support the application of data-management and data-sharing principles (e.g., FAIR1[1] and open data), and the release of technologies and tools that are open source and open access in citizen science initiatives, in order to ensure that citizen science data, technologies and tools are fit for science and policy purposes and, eventually, policy implementation.

3. STRENGTHEN FUTURE CITIZEN SCIENCE SYSTEMS

• Citizen science should be mainstreamed across the new Horizon Europe framework programme; this programme should also incorporate lessons from citizen science projects, and advice from citizen science experts, including on issues related to the European Green Deal.

• Curricula related to citizen science and the SDGs need to be developed for schools, higher education institutions and lifelong learning programmes, and adapted to different target groups. EU funding bodies should set up actions: support training and education institutes in incorporating citizen science; provide technical and legal support for citizen science practitioners; and reach out to local communities and schools.

• Funding for research into the science of citizen science is needed to advance the field, and how it can help achieve the SDGs and build expertise in a sustainable way.

• Funding for citizen science should allow for the special requirements of citizen science initiatives, including (among others) support for series of often small-scale experimentation, as well as for exploring different routes for the upscaling and long-term sustainability of initiatives aiming for social change.

1 Findable, accessible, interoperable, reusable

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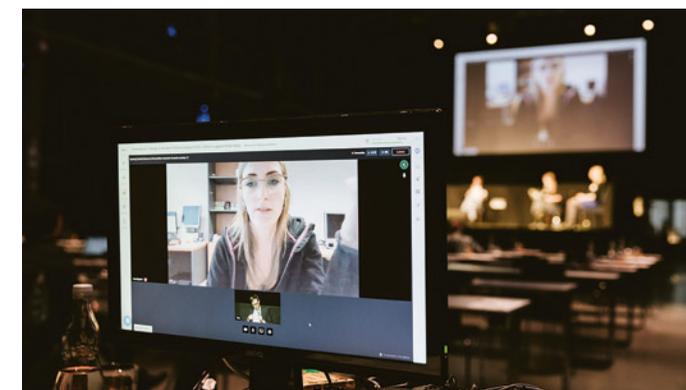
Voices, impressions and quotes

"Citizen science can contribute to achieving the sustainable development goals, such as making people aware of life on land and below water while also providing the data and evidence of where more effort is needed, to ensure that no one is left behind."

Muki Haklay, University College London, United Kingdom

"Citizen science can substantially contribute to science as well as to quality education — and we need to ensure inclusive and equitable access as well for citizen science activities."

Philipp Schrögel, Karlsruher Institut für Technologie, Germany

"Involving people in what impacts them is the gateway to a sustainable future."

Jan-Philipp Beck, EIT Health, Germany

"While we navigate the COVID-19 pandemic, involving citizens as active participants in research will prove crucial in achieving the SDGs. It's the way forward."

Margarida Sardo, University of the West of England Bristol, United Kingdom

"The SDGs very much require public engagement, not only to sustain the pressure on governments and businesses to take action, but also to generate the broad societal changes needed to make the goals actually achievable - these are both areas where citizen science can play a crucial role."

Alexandra Albert, University College London, United Kingdom

"The COVID-19 crisis showed growing online activities and the importance of platforms in international collaborations towards the SDGs."

Colombe Warin, European Commission

"Citizen science is a key path to support and empower people to walk and take action towards the SGDs."

Macarena Cárdenas, Earthwatch Europe, United Kingdom

"Co-creating scientific knowledge with citizens and ensuring the social impact of research, the way to achieving the Social Development Goals."

Marta Soler, Universitat de Barcelona, Spain

"Citizens should be involved in the agenda-setting process corresponding to climate change challenges."

Norbert Steinhaus, Science Shop Bonn, Germany

"New technologies, especially in IoT, provide a massive opportunity in a variety of fields such as mobility, like the WeCount-project, to engage and enable citizens directly in achieving SDG through citizen science."

Kris Vanherle, Transport & Mobility Leuven, Belgium

"Citizen science can engage the layman in the institutional implementation of the SDGs, specifically for what regards the promotion of human health and a healthy environment, being a form of environmental human rights 'in action'."

Anna Berti Suman, Tilburg University & The European Commission Joint Research Research Center, Italy