COOKBOOK

Guidelines for creating successful and sustainable Citizen Observatories

The WeObserve Cookbook has been especially designed for groups or individuals who are leading or will lead Citizen Observatory projects and initiatives. It provides lessons on best practice and guides users through resources such as tools, scientific papers, training materials and networks.

The guidance, tools, resources and insights captured in the Cookbook have been produced, tested and reviewed by the WeObserve project consortium and/or the WeObserve Communities of Practice. Many of the resources are well-documented and have been widely used in citizen science and citizen observatory projects. Most descriptions include a key reference, so you can explore more about their background or their application.

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The online version of the WeObserve Cookbook is constantly evolving and is available here: https://www.weobserve.eu/weobserve-cookbook/

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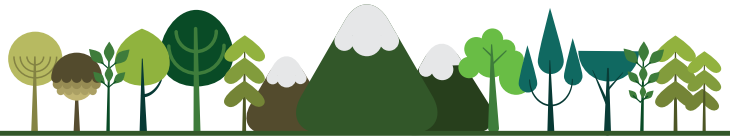

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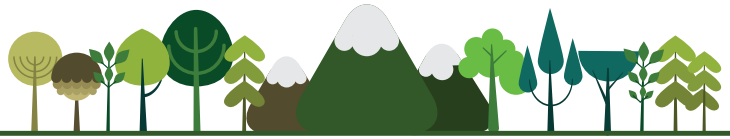

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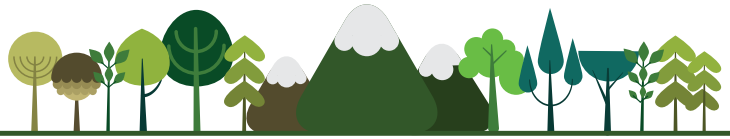

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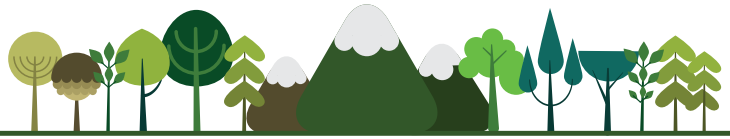

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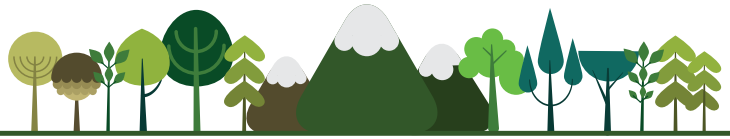


I want to understand what citizen observatories are

by learning about their characteristics

Why is it relevant?

There is growing interest in and curiosity about Citizen Observatories. By learning more about their specific characteristics and how they fit within the wider field of citizen science, you will better understand their unique potential. This will help you to know what factors to consider when designing, launching or engaging with Citizen Observatories.

What are the characteristics of Citizen Observatories?

Citizen Observatories are community-based environmental monitoring and information systems.

When the term 'Citizen Observatories' first emerged in the early 2010s, Alan Grainger from the University of Leeds defined them as The simplest and most broadly applicable definition comes from Alan Grainger. He defined Citizen Observatories as any use of Earth observation technology in which citizens collect data and are empowered by the information generated from these data to participate in environmental management. Since then the concept of Citizen Observatories has evolved beyond that.

Useful Resources

TALK: This talk about **"Citizen Observatories"** by Alan Grainger, University of Leeds, answers questions regarding the potential of Citizen Observatories in monitoring forest and landscape restoration.

PROJECT REPORTS: From our research into the EU Landscape of Citizen Observatories within the WeObserve project we produced two reports: one about the **frameworks** that can be used to describe Citizen Observatories and one with **insights** from the experiences of Citizen Observatories.

WEBINAR: **"Let's talk about Citizen Observatories!"**, hosted by the COs4Cloud project. The slides for the first talk in this webinar are **here.**

While there is no one official definition, the common characteristics of Citizen Observatories are:

1. citizen participation in environmental monitoring and governance,
2. typically at the community level or in a specific location, even if linked to a national or global environmental concern,
3. in which citizens use modern mobile and web technologies and/or sensors to collect and share data,
4. which enhance Earth observation systems and official data sources by filling in gaps and adding detail,
5. supporting the flow of data and information between citizens, scientists and decision-makers,
6. with a focus on influencing decision-making, policy change and/or environmental governance outcomes.

Two models of recent Citizen Observatories are presented below.

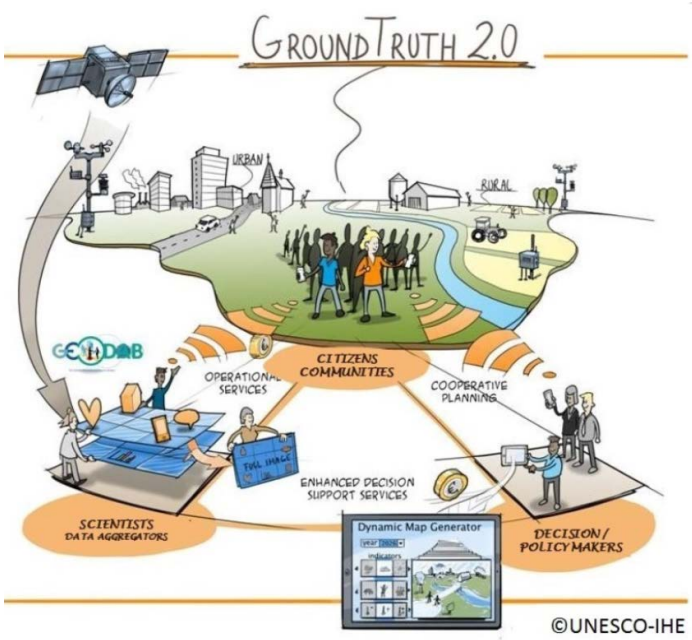


Image: Illustration of Citizen Observatories by the Ground Truth 2.0 project

▶ **VIDEO: Citizens' Observatories: Empowering European Society** – This video gives some concrete examples of how citizens can contribute to monitoring the environment using novel Earth observation technologies in the framework of Citizen Observatories.

CONFERENCE SESSION: "Citizen Observatories: the landscape, tools & data innovations for sustainable development " provides an overview of the current landscape of Citizen Observatories and presents innovations from them, such as new methodologies and conceptual models, as well as data innovations from hackathons, innovation and open data challenges. This programme session was held at the 'Citizen Science and the SDGs' conference hosted by the *Museum fur Naturkunde*, Berlin, in October 2020

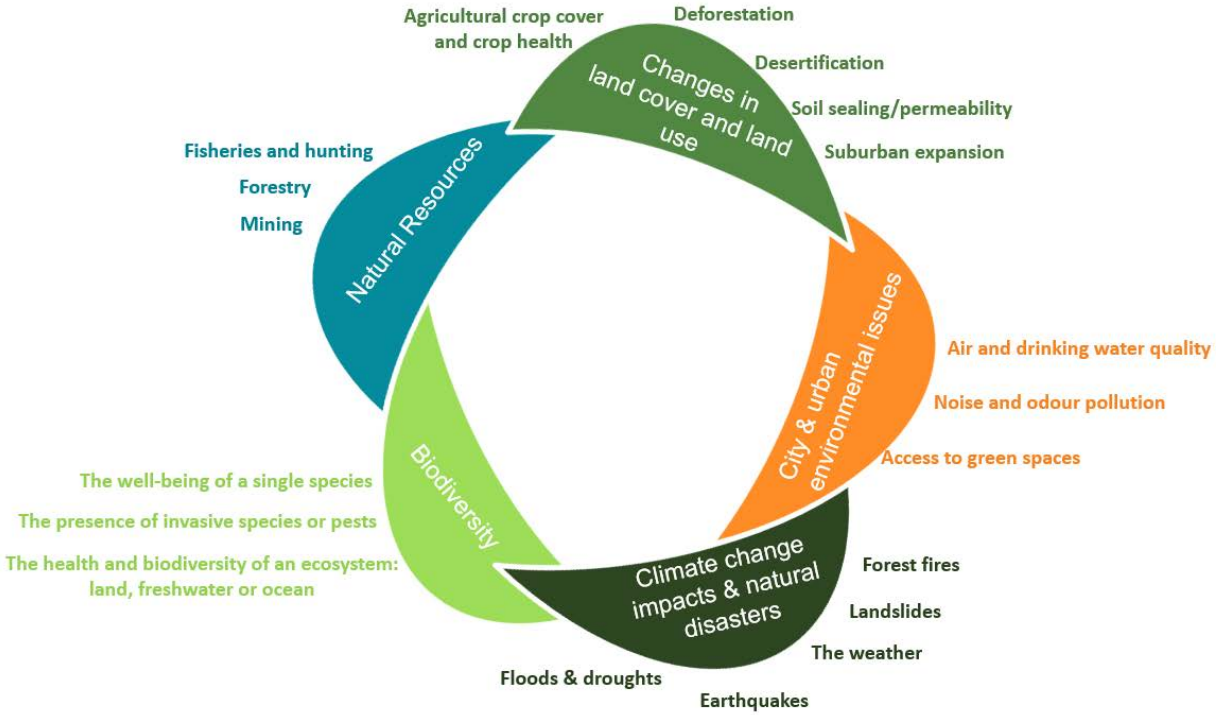
Image: GROW Observatory

You may also be interested in:

I want to understand what Citizen Observatories are...

...by learning about their history

Citizen Observatories can be set up to monitor issues such as:



This section partially draws upon the MOOC Citizen Science Projects: *How to make a difference* , though the focus was shifted from citizen science projects to Citizen Observatories.

I want to understand what Citizen Observatories are

by learning about their history

Why is it relevant?

Citizen Observatories (also known as Citizens' Observatories) have been around since the early 2010s. Many earlier initiatives can be characterised as Citizen Observatories, even if they did not use that term. There is therefore a sizable body of experience and examples that we can now learn from.

What is the history of Citizen Observatories?

Although Citizen Observatories have only existed under that name since the early 2010s, they have a rich and detailed history, which has resulted in the current Citizen Observatory landscape. Through various streams of funding, a wide variety of Citizen Observatories, focusing on various issues, have been set up over the past decades.

- Origin of the term 'Citizen Observatory'

The term 'Citizen Observatory' comes from the fields of environmental monitoring and Earth observation via satellite technology. Citizen Observatories build on citizen science approaches and focus on understanding and looking after our environment. They are part of a movement to empower communities to monitor their local environment and access the information needed to make effective environmental governance decisions. Citizen Observatories aim to bring together citizens, scientists and decision makers for better governance informed by citizen science data.

Useful Resources

PROJECT REPORTS: From our research into the EU Landscape of Citizen Observatories within the WeObserve project, we produced three reports: a report that outlines **frameworks which can be used to describe and compare Citizen Observatories**, a report on the **insights from the experiences of Citizen Observatories**, and a **Roadmap report** that sets the stage for future Citizen Observatories.

CONFERENCE PRESENTATION: "Lessons from the WeObserve project to strengthen awareness, acceptability and sustainability of Citizen Observatories in Europe" – Presentation at the virtual ECSA conference 2020.

The first use of the term Citizen Observatory, to our knowledge, appears in Prof. Jacqueline McGlade's 2009 Earthwatch Lecture entitled "Global Citizen Observatory – The role of individuals in observing and understanding our changing world", in which she stated that "*it is no longer sufficient to develop passive lists or reports to 'inform' citizens of changes in our environment. We need to engage with citizens and ask how they can 'inform' us.*"

In her abstract for the lecture, she calls for the use of Earth observation systems such as Global Monitoring for Environment and Security (GMES) (now known as Copernicus) and the Shared Environmental Information System (SEIS). Collecting and using local knowledge in this way will "help us empower citizens and … give us a better indication of what we need to do to be truly sustainable".

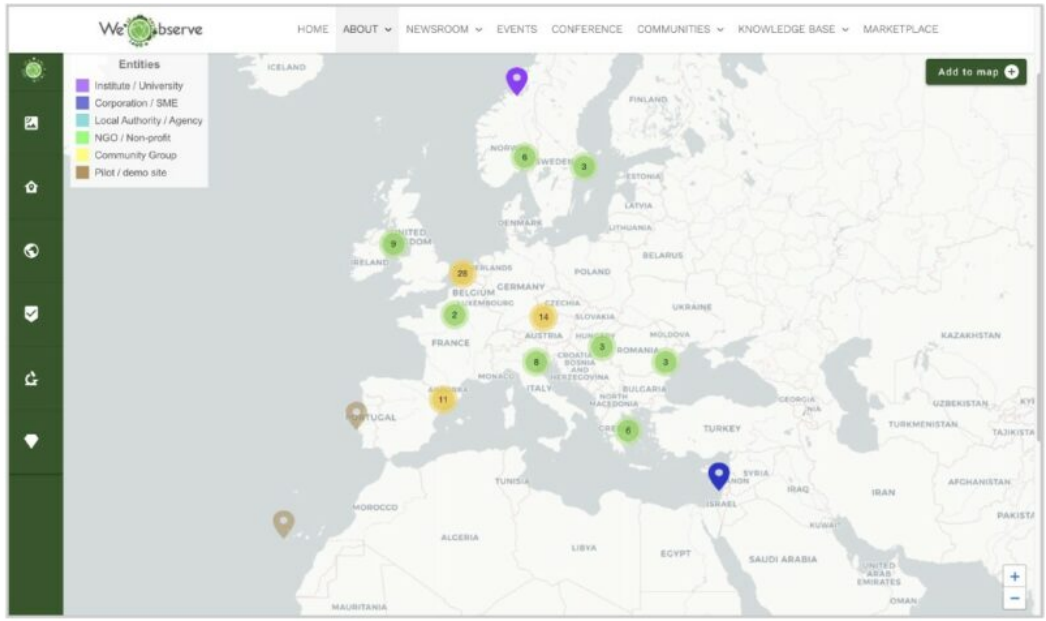
CONFERENCE PRESENTATION

"New Community Activity on Citizens' Observatories and Crowdsourcing" - Presentation at the Citizen GEOSS Workshop in St Petersburg (Russia), 8 November 2016, by José Miguel Iglesias

– The landscape of Citizens Observatories in Europe

To be able to report on the landscape of Citizen Observatories in Europe, the WeObserve project compiled a list of the Citizen Observatories that were funded under the EU FP7 and Horizon 2020 programmes.

These Citizen Observatories have been mapped on the WeObserve website in a Citizen Observatory Landscape Map that continues to grow as other practitioners and initiative leaders add their own Citizen Observatory initiatives to the picture. It illustrates the growing range of Citizen Observatories across Europe and can be filtered to highlight different aspects such as project, entity, domain, status, scope and/or funding.



Screenshot of the CO Landscape Map on the WeObserve Knowledge Hub (20/11/2020)

A comprehensive list of the Citizen Observatories and Citizen Observatory-type projects funded by the EU through the FP7 and Horizon 2020 programmes is shown in the table below. The list was taken from the "D2.9 Roadmap for the uptake of the Citizen Observatory knowledge base" (WeObserve Consortium, 2021).

FP7-funded	Focus	Timeline
COBWEB	Biosphere monitoring	2012-2016
OMNISCIENTIS	Odour monitoring	2012-2014
CITI-SENSE	Air pollution monitoring	2012-2016
WeSenseIt	Flood and drought monitoring	2012-2016
Citclops	Coastal and marine water quality monitoring	2012-2015

H2020-funded	Focus	Timeline
Making Sense	Open design and digital maker practices, DIY environmental monitoring, air, water, soil and sound pollution	2015-2017
CAPTOR	Combining citizen science, collaborative networks and environmental grassroots social activism to raise awareness and find solutions to the air pollution problem	2016-2018
hackAIR	Development of an open technology toolkit for Citizens' Observatories focusing on air quality	2016-2018
Ground Truth 2.0	Flood risk management, environmental quality of life, land and natural resources management, sustainable livelihoods, climate change adaptation	2016-2019
GROW Observatory	Soil, land use, crop planting and water resources	2016-2019
LandSense	Land use and land cover monitoring	2016-2020
Scent	Water supply and quality, flood risks	2016-2019

H2020-funded	Focus	Timeline
SMURBS (ERA-Planet)	Integration of EO and Citizen Observations for a common approach to enhance urban environmental and societal resilience	2017-2021
WeObserve	Knowledge consolidation and mainstreaming of Citizen Observatories	2017-2021
DNoses	Odour monitoring	2018-2021
Monocle	Water quality monitoring	2018-2022
CitieS-Health	Assessing urban air and noise pollution and their links to health impacts	2019-2021
MICS	Measuring impacts of citizen science, nature-based solutions, water quality and biodiversity	2019-2021
WeCount	Urban road transport monitoring	2019-2021
TeRRIFICA	Adaptation processes to climate change through living labs, crowd-mapping and co-design	2019-2022
Cos4CLOUD	Interoperability and integration of Citizen Observatory technology and data with the European Open Science Cloud	2019-2023
DIONE	Complementing EO data with farmer-based monitoring to inform CAP regulations and decision-making at farm level	2020-2022
FRAMEwork	Citizen Observatory for monitoring biodiversity in farmland landscapes	2020-2025

- **Evolution of Citizen Observatories across funding programmes**

Looking at the historical pathway from the first Citizen Observatories funded by the European Union, there are now also a range of examples supported by national funding schemes (e.g. in Spain and the Netherlands) and by private sector funding (e.g. Coca Cola Foundation).

You may also be interested in:

I want to understand what Citizen Observatories are...

...by learning about their characteristics

I want to set up a citizen observatory
by building a community

Why is it relevant?

The target audience for a Citizen Observatory might be a group of people who live in the same place, they might be similarly impacted by an environmental issue no matter where they live, or they may simply share a concern for a common environmental issue. The aim of building a community is for all observatory members to come to a shared understanding of the issue, the goals of the observatory, the organisation of the observatory, and how to perform and document the tasks ahead.

How can this be done?

Building a community entails raising awareness, supporting and encouraging two-way communication, appointing a community manager and fostering and encouraging deeper engagement.

- Raising awareness

Raising awareness about your Citizen Observatory and its goals is the first step towards building an active community. Key questions are: Who is your target audience? and How will you communicate with them? Consider which newspapers, social media channels, local community bulletin boards and other channels might be good ways to raise awareness and reach potential participants. Reach out as widely as you can to groups of people who are outside of your usual circles, who also share your concerns and have a stake in the outcome of your campaign. For example, adjacent neighbourhoods and different age groups may be easy to reach and similarly affected.

Useful Resources

TOOL: **The Making Sense toolkit** includes an **Onboarding Kit** (p 40-43) with guidance on how to welcome and guide a new participant into the project and the team. It also provides **recruitment tips** (p 48-51) on how to reach out to multiple relevant communities and how to bring them on board.

PROJECT REPORT: This **Ground Truth 2.0 report** explains the **community building approach** and associated stakeholder engagement used in different Citizen Observatories in Europe and Africa.

PROJECT REPORT: **This Ground Truth 2.0 report** contains methods, techniques and tools for community building during each stage of a larger co-design process of a Citizen Observatory.

Here are some methods for raising awareness:

- Setting up a website,
- Setting up a Facebook page or group,
- Setting up a dedicated Twitter account,
- Setting up other types of social media accounts,
- Starting a digital or print newsletter,
- Running events that are listed on MeetUp or Eventbrite,
- Getting local radio or news coverage,
- Making flyers to hand out at local events or distribute from community centres,
- Making posters to hang in public spaces,
- Setting up promotional stands at community events,
- Asking existing community groups to help you spread the word via their channels,
- Writing regular short episodic stories on Medium or similar platform (e.g. https://medium.com/grow-observatory-blog/places/home),
- Creating an Onboarding Kit that welcomes and guides a new participant into the observatory and the team – this could include informative resources as well as community-building tools, and
- Mapping your team's skills to identify gaps and carry out more effective recruitment efforts,

Once a critical mass of stakeholders are on board, there are different ways of co-designing the Citizen Observatory with them – you can find out more here.

– Supporting and encouraging two-way communication

Once the observatory has been set up, consider how you will keep in touch with participants and how they will keep in touch with each other. You can use many of the same channels that you established for raising awareness about your project to share ongoing developments with all participants.

Do you have a website to which all community members can add content? Can community members share photos, experiences and discoveries via social media?

Maybe you'd like to add a social element to data collection activities. For example, if a community in the same geographic area is collecting information on a local concern, they can have weekly 'meet-ups' to discuss the challenges they face or share insights or news.

Take the time to ask participants how they would like to communicate with each other and how they can encourage more people to get involved.

Remember that part of building a real sense of community includes the leaders or organisers as well – you and your team should be visible to the participants. If your means of communication are primarily digital, make sure that you are frequently sharing videos and photos so that participants also have a sense of who you are.

– Appoint a community manager

Make sure that questions and comments on your digital channels get answered. Assign a member of the team, or rotate who is 'on-duty', to check all channels regularly. A good community manager needs to be proactive in sharing information and news. If you cannot answer a question yourself, connect your team with someone else who can. Make sure that any suggestions or feedback are shared in a usable way.

This role is critical to the success of any online community but does not have to be filled 24/7. As long as members of the community receive responses in a timely fashion, they will be able to trust the shared communication channel that is being used. Within 24 hours is a reasonable period. However, a community manager needs to also encourage participants to answer questions themselves and actively help each other as well.

It is useful to set expectations with all participants as to how each communication channel should be used, and the community manager should actively moderate this. This can be by way of a formal user agreement, or simply a clear statement about what is considered good or bad behaviour on that channel. For example, if you want to encourage social interaction among your team but want to keep the data channel clear of chat messages, encourage members to set up a separate channel for social conversations.

– Foster and encourage deeper engagement

Community members are most engaged when they can play a meaningful role in shaping the project, helping to make key decisions and plan how to use the resulting data for maximum impact. Make sure that you and your team include all participants in decision-making as much as possible and enable them to get more deeply involved throughout the process.

Examples include:

- Inviting participants to write guest blog posts,
- Inviting participants to help design campaign materials and lead their own awareness-raising activities,
- Holding community-wide meetings to share progress, make suggestions for improvements and plan the next actions together,
- Creating opportunities for participants to share their experiences and local knowledge of the issue with key decision-makers,
- Inviting participants to present outcomes about the issue to key external stakeholders,
- Sharing project data with participants while being sure to always follow sensitive data privacy regulations (e.g. not publishing personal information) to encourage data innovation, and
- Inviting ideas for other initiatives that might benefit the project.

Consider which of the above activities would be most effective for the issues that your community members want to focus on.

Lessons learned from the Ground Truth 2.0 project

A community consists of stakeholders who identify or perceive themselves as being a part of it. For Ground Truth 2.0, a community of relevant stakeholders is at the heart of a Citizen Observatory. Community building in the Ground Truth 2.0 project was done by fostering social interactions that led stakeholders to identify with the group outcome, which requires not just intellectual, but also emotional experiences. Visible and symbolic acts, such as signing a consent form, registering an account for an app, posting to an online platform, participating in planning meetings, or in organised data collection campaigns, all served to create a sense of 'membership' and being a part of something bigger.

*Source: **Anema et al. 2018***

It is also important to distinguish between the initial group who sets up an observatory (often a co-design group) and the long-term community. Ground Truth 2.0 found that it is useful to approach community building in four phases to evolve a Citizen Observatory community from an initial group into a social movement:

1. ***Initiation stage:*** *The first core community members of a Citizen Observatory are recruited. With their input and participation in a co-design process, the observatory starts to take shape.*

2. ***Stabilisation stage:*** *Shared group values and norms, important for bonding within any community, are (implicitly or explicitly) developed.*

3. ***Enlarging the Citizen Observatory core community:*** *The community of active participants grows. More stakeholder groups will be invited to join, and the interactions in the observatories should multiply.*

4. ***Maintaining the community:*** *In this final stage, less attention is directed toward recruitment or gaining the interest of potential new community members. Instead, the established Citizen Observatory focuses on sustaining the community members they have already engaged and on embedding continuity in their interactions.*

Lesson learned by the LandSense and GROW projects

In the LandSense Citizen Observatory, a wide range of stakeholders have been involved, so the ways of building community have varied from case to case. In the urban case studies in Vienna, Amsterdam and Toulouse, it has been critical to engage the city administration or different local authorities who will use the data so that they have an interest in participating. In the agricultural case study, farmers and agricultural extension workers have been the key stakeholders, while for forest and habitat monitoring in Indonesia, local communities have been engaged to help co-design the Natura Alert solution.

No matter what context we work in, good communication and co-creation have been vital for building strong communities with a vested interest in the success of the Citizen Observatory. The GROW Observatory ran several citizen science activities. The main soil sensing activity was happening in GROW Places across Europe. When recruiting participants in these places, we followed a set of criteria to make sure we would have a wide range of people from different climates, agricultural contexts and socio-economic contexts. Each GROW Place was coordinated by a local Community Champion. GROW also developed a Community of Practice for Community Champions to foster collaborations across GROW Places and keep up the momentum after the GROW projects had ended.

You may also be interested in:

I want to set up a Citizen Observatory...

...by identifying a shared issue

...through a suitable co-design process

...by finding and secure funding

...by complying with ethics

This section partially draws up the MOOC *Citizen Science Projects: How to make a difference,* though the focus was shifted from citizen science projects to Citizen Observatories.

I want to set up a citizen observatory
by identifying a shared issue

Why is it relevant?

Suppose that an environmental issue directly concerns you, and you want to do something about it. You suspect other people in your community might also be affected by the same issue. It is important to find out if the issue affects more than one person and to identify its cause. For example, bad smells in a neighbourhood might be due to a lack of adequate rubbish facilities.

How can this be done?

If you are concerned about an environmental issue, e.g. noise, air pollution, illegal dumping, etc., talk to your neighbours to find out if they are also affected by it. This 'talking' can be done in many ways. Your shared concern can help mobilise a community to act. Keep in mind that a community does not always mean acting only locally – a community can also be national or even global. Similar environmental issues affect many people around the world.

Once a group is formed around the shared concern, you can start to discuss what aspects of this issue are particularly relevant to the community. The next step is to think of how it could be addressed by a Citizen Observatory. To do this, the group will have to consider what dimensions are possible to observe and monitor (e.g. amount of dumping or levels of noise). Once the focus is clearer, you can start building a community (more on that here and here) and select a suitable co-design approach (more on that here) to agree on the specific goals and the ways of working and monitoring that your Citizen Observatory will have.

Useful Resources

TOOL: The **Empathy Timeline tool** is designed for community members and citizen science practitioners wanting to start a new project. It is designed to be used at the beginning of a citizen science project and involves asking community members to think about the complexities of the shared issue they would like to monitor..

TOOL: Although called an 'evaluation tool', **this resource** facilitates discussions at any stage and can also be used at the beginning of a Citizen Observatory process. It can help a community to identify the key dimensions of the shared issue that matters most to them and that they would like to find a way of monitoring.

Before you start a Citizen Observatory, the group will need some awareness of the environmental policies, laws or regulations that apply to the shared issue, e.g. in relation to legal limits or existing campaigns to tackle the same problem.

- Geographic Mapping

Find out the nature and locations of problem hotspots, and map them (to learn about mapping, see the "Useful resources" section. You can add data to your map, such as proximity to resources and schools, that can inform you about which stakeholders should be brought on board.

- Commons Mapping

To define the key types of contributions required for your Citizen Observatory, it might be useful to hold a Commons Mapping exercise (see “Useful resources” below). This allows people to identify and log contributions that are needed and that they are willing to make. Write these ideas down on a large sheet of paper or wall canvas under demarcated categories, so that they can be openly seen and discussed by all participants. The categories can vary depending on your Citizen Observatory’s focus, but ‘Stakeholders’, ‘Technology’, ‘Workshops’, ‘Development’ and ‘Resources’ are common examples.

> ***Identifying the issues: The example of air pollution***
>
> ***Is it an issue where you are?***
>
> *First, make sure that this issue is one that affects your local area. Maybe you experience health issues yourself or have been talking to neighbours who take their children to school along congested streets.*

TOOL: Citizen Sensing: A Toolkit contains the **Geographic Mapping** and **Commons Mapping** feature to find out the nature and the location as well as the specific needs of the issue.

What are the current policies?

The next step is to learn about the safe pollution limits currently set by countries, regions (such as the EU) and organisations like the World Health Organization (WHO).

What's the question?

Finally, you can ask the question: Does the air pollution in my local area exceed safe limits? Even if limits are observed, is there a critical mass of interest in improving the current air quality level?

Example from the Making Sense project – Using the empathy timeline tool in Kosovo

Making Sense was an international project, designed to show how digital, open-source practices can help local communities make sense of their environments. To do this, Making Sense often used Empathy Timelines, which allow for better understanding of the relevant issue by encouraging us to look at both sides of the problem and how we might understand our role in it.

In Prishtina (Kosovo), Making Sense brought together young students and primary school communities to create Empathy Timelines reflecting the impact of air pollution in the city. With these communities, Making Sense posed the question: How are you affected by the air pollution, and how did you contribute to better air quality in the last 24 hours?

Participants formed small groups and mapped their daily encounters with air pollution. The participants then used a second timeline to detail their contributions to air quality over a typical 24-hour period. Each small group then reflected on their two timelines, noting the positives and negatives on each timeline, before discussing their timelines with the wider group.

This exercise allowed participants to visualise the wide range of day-to-day impacts caused by air pollution, while also identifying shared issues and methods for approaching these issues together.

You may also be interested in:

I want to set up a Citizen Observatory...

...by building a community

...through a suitable co-design process

...by finding and secure funding

...by complying with ethics

I want to set up a citizen observatory **through a suitable co-design process**

Why is it relevant?

Along with the increasing popularity of Citizen Observatories, there is also emerging evidence of difficulties with their implementation. Co-design approaches can help ensure success from the start of the initiative.

How can this be done?

There is no one perfect method or blueprint for co-designing Citizen Observatories. Rather, the appropriateness of a given approach depends on the conditions, resources and purpose (i.e., data collection versus social change) of the new observatory. Nevertheless, most co-design approaches that have been applied to Citizen Observatories share some fundamental principles, such as including different stakeholder perspectives when defining the goal of a Citizen Observatory and agreeing on the ways of working.

Example from the Ground Truth 2.0 project

Ground Truth 2.0 considers Citizen Observatories to be true social innovations, addressing societal challenges by combining new social practices and technological innovations. The Ground Truth 2.0 co-design methodology was developed to facilitate setting up Citizen Observatories that are meaningful and helpful for (local) stakeholders in achieving impact and change. It combines the social, technological and operational dimensions of a Citizen Observatory in one coherent process. The approach brings relevant actors together, guiding them towards a shared understanding and purpose of their Citizen Observatory. It also tailors digital innovations to enable participants to actively collaborate in the collection, exchange and use of information and knowledge.

Useful Resources

PROJECT REPORT: This report contains guidance for co-designing a Citizen Observatory using the **Ground Truth 2.0 co-design methodology**. It includes an inventory of suggested methods, techniques and tools for each stage of the process.

WEBSITE: An **overview of the Citizen Observatories** that were set up using the Ground Truth 2.0 co-design methodology.

TOOLKIT: The **WeObserve Toolkit: Co-designing your observatory** includes a range of open access tools developed by WeObserve partners, including some specifically for co-designing Citizen Observatories.

CoP: The **WeObserve Co-design & Engage Community of Practice** brings together practitioners of Citizen Observatories and citizen science to share and learn different ways

The Ground Truth 2.0 co-design methodology is adaptable to different geographical contexts, social settings and environmental issues. It has been successfully used in four European and two African countries, producing meaningful results in settings ranging from rural Zambia to urban Belgium.

Example from the Making Sense project

The Making Sense, project aimed to achieve action and change through a design research and co-creation approach. The project invited local communities to use open source software, open-source hardware, digital maker practices and open-source design to address pressing environmental problems.

Making Sense utilised a conceptual and methodological framework (see image below) to provide citizens and communities with the tools they need to enhance the community's everyday environmental awareness. The stages and principles in the framework serve as a guide to help participants know what is happening at all points in the process. They are specifically geared towards supporting collaborative working methods and community action. The stages of the framework provide an idea of who is involved at which

of co-designing Citizen Observatories.

TOOLKIT: **Citizen Sensing: A Toolkit** is a collection of tools from the Making Sense project, many of which support a co-design approach in citizen science.

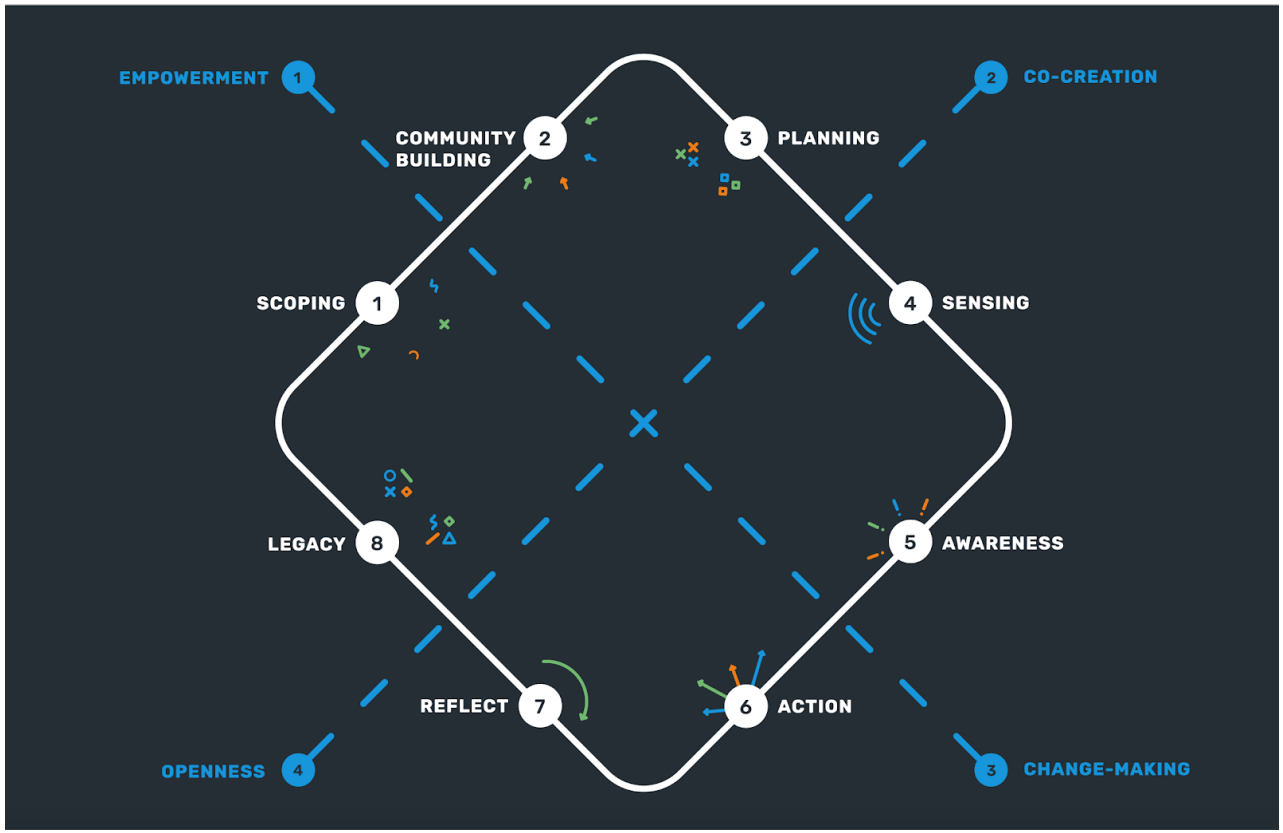
SCIENTIFIC PAPER: "Making Sense: Empowering participatory sensing with transformation design" demonstrates the value of co-design in citizen science projects through a case study on Making Sense.

SCIENTIFIC PAPER: "Stop the Noise! Enhancing Meaningfulness in Participatory Sensing with Community Level Indicators" demonstrates the value of using a co-design approach through an entire citizen science campaign in Barcelona.

CARD GAME: ***"Design for Climate Services: A Co-Design Approach"*** is a co-design card game for developing citizen

point, what usually happens at that time, and key objectives or milestones to be achieved at each stage so that you know when to move on. The four principles lie at the heart of the process, governing the ethics of the project as a whole. They are intended to serve as a guide for participants in all stages of the project.

The steps are: ***Scoping, Community Building, Planning, Sensing, Awareness, Action, Reflect and Legacy****. The cross-cutting principles are* ***Co-creation, Empowerment, Openness,*** *and* ***Change-making****.*



The Making Sense framework, showing eight steps and four cross-cutting principles

science projects. It was initially developed during the GROW project and was also tested during a one-day workshop called ***"Imagining the transformative future of Citizen Observatories to leverage the power of open data, technology and citizen science",*** held at the Transformations conference in Chile in October 2019.

PROJECT REPORT: "**GROW Observatory: Mission Outcomes**" demonstrates the co-design approaches used during a CO project.

You may also be interested in:

I want to set up a Citizen Observatory...

...by building a community

...by identifying a shared issue

...by finding and secure funding

...by complying with ethics

I want to set up a citizen observatory **and need to secure funding**

Why is it relevant?

No matter what type of Citizen Observatory you wish to set up, you will need sufficient funding to ensure its successful start and its continuation. Significant effort goes into creating an engaged community of participants and setting up the technical infrastructure that supports the different phases of the environmental monitoring process. Both have financial implications.

How can this be done?

Citizen Observatories employ different operational models, depending on their scope and their expected structure, geographical scale, duration and participation. These elements determine the form of funding that can be used to finance the Citizen Observatory.

- Research and innovation funding

For Citizen Observatories that aim to create new scientific or technical knowledge, or to demonstrate pilot and/or operational methods, funding from research and innovation programmes and grants are a realistic opportunity. Such projects are usually based on multidisciplinary consortia, including collaboration between academia and research institutes, industry, NGOs, volunteer organisations and public bodies. They typically include large-scale activities over a maximum duration of 5 years. Funding for Citizen Observatories has been gaining momentum since the European Commission's Seventh Framework Programme and including the Horizon 2020 Framework Programme. Horizon Europe, the EU's research and innovation framework programme from 2021-2027, is another funding source that can offer financial support to the work of Citizen Observatories.

Useful Resources

WEBSITE: European Commission **funding opportunities**, such as Coordination and Support Actions (CSA), Research and Innovation Actions (RIA), Responsible Research and Innovation (RRI) and specific thematic calls.

WEBSITE: **Platforms** for crowdfunding citizen science research in search of funding, such as Kickstarter, Indiegogo, Rockethub and Experiment.

SCIENTIFIC PAPER: "**Crowdfunding Scientific Research: Descriptive insights and correlates of funding success**" presents a review of dedicated platforms for crowdfunding research and highlights differences between crowdfunding and traditional funding mechanisms for research.

– Crowdfunding

Crowdfunding can be useful for Citizen Observatories that have a limited spatial and temporal scale but which may continue and even expand in the future (e.g. Community Air Pollution Monitoring). Moreover, in reward-based crowdfunding, an all-or-nothing funding strategy can be applied: projects must set funding goals, and supporters only pay if that goal is met. This is appealing to many donors, since it means they are not spending money on a project that does not receive enough donations to operate or complete its mission.

POLICY BRIEF: This **policy brief** from the DITOS project analyses existing funding practices across a range of citizen science projects.

Example from Mapping for Change

Mapping for Change is a social enterprise based in London that engages with communities around the UK to map air pollution across the country.

Image: Mapping for Change

In 2016, using online small crowdsourcing (SCS), they were able to secure funding from 26 individual funders to develop a Community Air Pollution Monitoring Map and Equipment library. With this they were able to purchase more sensors, which further supported communities in mapping air quality.

You may also be interested in:

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...by complying with ethics

– Diversification of funding

Longer standing initiatives led by civil society organisations are able to experiment and diversify their funding, thereby identifying the sources that best fit their needs. For example, The Riverfly Partnership is a dynamic network of organisations that run a range of projects related to the interests of the partners. Because of the long-term commitment of participating organisations, various streams of funding can be examined for each project in order to identify the most beneficial.

In some projects, various streams of funding can even be combined to achieve the necessary financial backing. Another funding option is to create a partnership that runs on membership fees. This works well when the predominant mission of the Citizen Observatory to be established is well aligned with those of the partners.

Lessons learned from the AfriAlliance project

The AfriAlliance project highlighted four key types of challenges facing small-scale projects looking to secure funding:

- *Capacity-related challenges,*
- *Administration-related challenges,*
- *Fund-related challenges,*
- *Process-related challenges.*

Due to these challenges, local and small-scale actors often need to develop innovative approaches to secure funding.

Image: AfriAlliance Policy Brief #2

I want to set up a citizen observatory **and comply with ethics**

Why is it relevant?

Ethics touch upon a range of topics, including mutual respect; gender, equality and inclusion; democratic participation; active learning; collective action; personal integrity; privacy; and data security. Ethics are essential to all areas of science, and as such should be incorporated into every aspect of a Citizen Observatory.

How can this be done?

Ethical practice dictates that Citizen Observatories should strive to use information that is up to date and well-grounded in relation to strategic policy and to technological, social and cultural developments, while also taking into account the needs and desires of the wide range of stakeholders that are involved. Naturally, this will require engaging with these stakeholders and potentially including them in the development of relevant ethical frameworks. The potential social and environmental impacts of Citizen Observatories should also be considered as part of the ethics of your Citizen Observatory.

Particular attention needs to be paid to the principle of proportionality, the right to privacy, the right to the protection of personal data, the right to physical and mental integrity, the right to non-discrimination and the need to ensure high levels of human health protection.

Useful Resources

TOOL: The **Data Ethics Canvas** is based on the Ethics Canvas (see above) and was developed by the Open Data Institute to help identify and manage ethical issues at the start of a project that uses data, and throughout.

TOOLS: The **Citizen Science Association (CSA) Working Group on Ethics** has developed a range of materials, ranging from **codes of ethics** to **consent forms** and **webinars**.

WEBSITE: GDPR.eu is an online resource to help you achieve compliance with the General Data Protection Regulation of the European Union.

To simplify ethics is to underestimate its potential complexity when applied, especially in Citizen Observatories. Nevertheless, ethics can be presented on the basis that

1. the research should do no harm, either physical or non-physical, and
2. participation in research should be voluntary.

By adopting ethical approaches across the board, the potential for poor practice is reduced. Ethics relate to 'responsibility' for all stakeholders within the research and innovation community. They are part of a broad paradigm and framework for Citizen Observatories that also form an important part of Responsible Research and Innovation (RRI).

- Structuring the ethical implications of your Citizen Observatory

The Ethics Canvas helps you structure ideas about the ethical implications of any project (so also your Citizen Observatory), allowing you to visualise them on the canvas and to resolve them. It was developed by the ADAPT Centre for Digital Content Technology and is itself based on the original Business Model Canvas by Alex Osterwalder.

Image: Ethics Canvas

PROJECT REPORT: The **LandSense Citizen Observatory user guidelines and training material** provides useful information on the GDPR and how it was handled in this Citizen Observatory.

TOOL: Under the umbrella of the European Citizen Science Association, an international community of citizen science practitioners and researchers produced Ten Principles **available in >25 languages** to foster excellence in all aspects of citizen science which can be equally applied to Citizen Observatories.

TOOLKIT: The **RRI Toolkit on Ethics** provides resources, tools and training materials to help promote research integrity and to integrate ethics into various phases of the research and innovation process.

VIDEO: This **CSA webinar** featuring scientific experts and citizen science experts, explores the challenges of meeting data collection needs while protecting participant privacy.

Among the range of issues to be addressed in order for Citizen Observatories to comply with ethical requirements, data security and data privacy are key. The General Data Protection Regulation is a European Union (EU) law on data privacy and security. This law came into force in May 2018 and imposes obligations on organizations anywhere that target or collect data related to people in the EU. As a general principle, you should limit the use of personal information to the minimum and define why you need it. The categories of personal data that are often collected and stored by Citizen Observatories are participant first name and surname; participant email address; participant organisation.

Lessons learned from the GROW project

The GROW Observatory conducted an exercise to foster long-term engagement for soil monitoring with people by understanding and reflecting on three key questions: 1) What is harm? 2) What is risk? 3) What is the benefit?

What is 'harm'?

We need to consider the probability of harm occurring, understand its severity, and explain any risks. Harm can include subjective evaluations like distress, embarrassment and anxiety, which can be difficult to either predict or to control for. Other typical harms include inconvenience, time lost, intrusion, and boredom or discomfort. These may not seem like serious issues, but they may be serious to the person concerned. People can feel mistreated by participating if, for example, they feel that they have not been treated well, have been deceived, or that their values have been disregarded. ***GROW explained harms and how probable and severe these might be, and listened to people's views.***

▶ **VIDEO:** This **presentation** provides a useful introduction to copyright and data protection in citizen science.

PROJECT REPORT: This **COST Action workshop report** (2020) describes work towards a citizens' information packet on legal and ethical issues around ICTs and highlights remaining data privacy and ethical/legal issues.

How is 'risk' defined?

Risk is vague and covers harm, but for GROW it was important and useful to consider practical matters such as incurred costs and inconvenience. In contrast, 'reward' implies that there will be a definite 'good' for the participant, wider community, society and even the environment. Assessing the 'risk-reward' balance involves evaluating the relative significance of these two areas. It can be useful to think of this as an assessment between risks and 'anticipated' benefits or rewards; this is a more tentative approach and possibly more honest. The danger is that we may justify any research by claiming huge hoped-for rewards at an individual or project level. ***GROW was clear about the risk and reward to the individual participant, e.g. community champions and, where appropriate, used a looser equation of risk to the participant and hoped-for benefits to society and the environment.***

How is ´benefit´ defined?

The GROW consortium was clear about the difference that having a vision and specifying the benefits to individual and personal objectives can mean for an organisation (e.g. reputation and publications), participants (citizen scientists and community champions) and the wider community. It was important to be realistic about what GROW could achieve. GROW intended to improve knowledge about soil and growing, and to demonstrate new innovative services for society. GROW needed to disseminate this in ways that participants could also access and understand. ***GROW was careful not to raise people's expectations unfairly, and to be honest and realistic about what would happen as a result of their involvement in the research.***

– General Data Protection Regulation

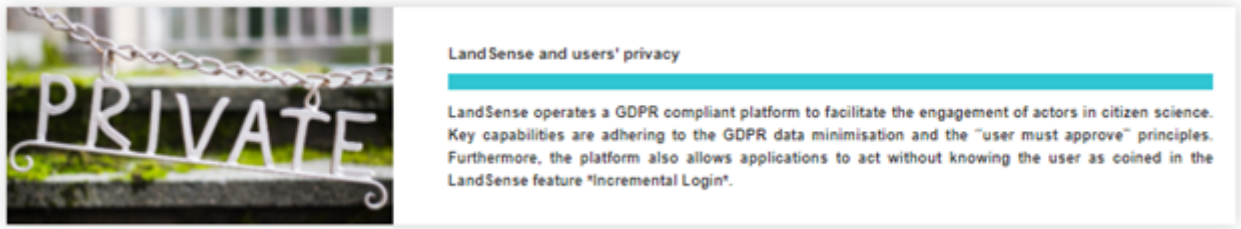
Among the range of issues to be addressed in order for Citizen Observatories to comply with ethical requirements, personal data security and protection, as well as privacy are key. The General Data Protection Regulation is a European Union (EU) law on data privacy and security. This law came into force in May 2018 and imposes obligations on organisations anywhere that target or collect data related to people in the EU.

As a general principle, you should limit the use of personal information to a minimum and define why you need it. The categories of personal data that are often collected and stored by Citizen Observatories are participant's first name and surname, participant's email address and participant's organisation.

Implementing data protection in the LandSense project

The LandSense Citizen Observatory links many different applications together, which have been developed by different partners. To ensure compliance with the General Data Protection Regulation in the EU, all applications that use any type of personal data must have an associated Privacy Statement. This statement clearly indicates the data that are collected (including any personal data) and the purpose for which the data will be used, providing users with complete transparency.

Users also always have opt-in consent, which means they must give their agreement to any application regarding their personal information, and they can request that their personal information be deleted at any time. In general, applications in LandSense have adopted a minimisation principle, i.e., only requesting personal information if it is necessary. Finally, any personal data are always securely stored in an encrypted database. More information can be found on the LandSense Engagement Platform.



– Recruitment of participants

Ethics are also relevant to the way in which participants are selected to join your Citizen Observatory. They are relevant to gender, equality and inclusion to ensure equitable and appropriate participation. The GROW project elaborated the following ethical questions, which can help you evaluate recruitment strategies that aim to ensure best practice:

- **Equitable selection of participants:** Does the recruitment strategy help to ensure that selection of participants is equitable and appropriate?
- **Respect for privacy:** Does the recruitment strategy respect an individual's reasonable expectations for privacy? Will participants recruited from an existing database have given their permission beforehand for this use of their information?
- **Lack of pressure:** Is the activity introduced in a way that allows subjects time to consider, with no undue pressure caused by the timing of the request, and no offering of excessive benefits or rewards?
- **Unbiased presentation:** Is all information accurate, balanced and free of misleading emphases? Is the information as complete as is appropriate?
- **Conflicting concerns:** Individuals in a community may feel under pressure from a community champion, colleagues may feel obliged to participate in a study if it is in geographic proximity to them, and students may feel obliged to join if a researcher is also their professor.

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I want to set up a Citizen Observatory...

...by building a community

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...through a suitable co-design process

...and finding and securing funding

I want to engage stakeholders

by understanding the context and identifying key stakeholders

Why is it relevant?

Engaging relevant stakeholders is key to running successful Citizen Observatories. A fundamental part of stakeholder engagement is identifying key stakeholders and the larger context in which a Citizen Observatory is (being) embedded in order to know who, why, how and when to engage.

How can this be done?

Deciding which stakeholders are relevant for a Citizen Observatory can be quite complex, especially given that Citizen Observatories are typically linked to (local) issues and policy. Moreover, stakeholders from the same category, e.g. citizens, can play distinctly different roles in an observatory, e.g. as initiator, core community member or observer only and need to be engaged accordingly.

It is therefore important to carefully map the context of the issue and the key stakeholders in order to navigate these. Simple context and stakeholder mapping is a generic approach that is being used in many project-related contexts. It can help to identify and specify the social, economic, environmental and political setting of the observatory as well as the roles, relationships and agendas of different actors.

Useful Resources

PROJECT REPORTS: These Ground Truth 2.0 reports explain the context and stakeholder mapping approach, including the adapted PESTEL. They present the findings of the **baseline context and stakeholder mapping** per case in Africa and Europe as well as the **subsequent updated analysis one year into the project**.

SCIENTIFIC PAPERS: The Ground Truth 2.0 project produced this **conceptual framework for context, process and impact analysis** and applied it in two of the Ground Truth 2.0 Citizen Observatories, **one in the Netherlands and one in Kenya** to create a baseline.

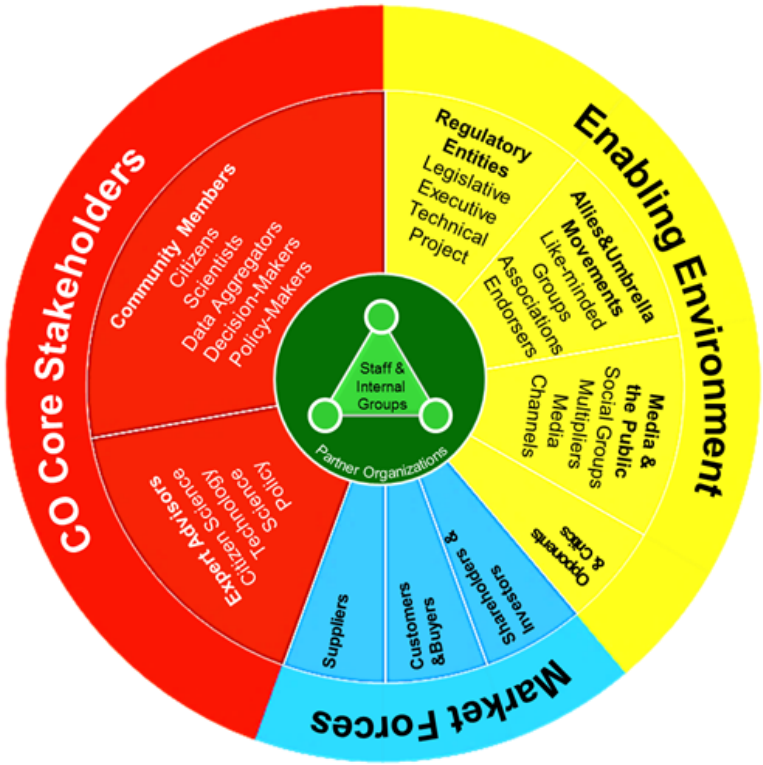
– Stakeholder Mapping

Context mapping and stakeholder mapping has been tailored and adapted to Citizen Observatories, given that Citizen Observatory characteristics add layers of complexity, for example by cutting across different environmental, political and administrative boundaries. The Ground Truth 2.0 context and stakeholder mapping approach captures relevant information for Citizen Observatories through team discussions or interview questions and combines this in a consolidated context and stakeholder map.

CoP: The **WeObserve Co-design & Engage Community of Practice** brings together practitioners of Citizen Observatories and citizen science to share and learn different ways of engaging stakeholders in Citizen Observatories.

Stakeholder analysis for Citizen Observatories – Example from the Ground Truth 2.0 project

The Ground Truth 2.0 project developed a generic stakeholder analysis for Citizen Observatories. This was applied in six countries (four in Europe, two in Africa), and the results identified ten main stakeholder categories. Stakeholders are deliberately listed as having more than one role (i.e., are placed in several categories), indicating potential role conflicts or the need to engage the same stakeholder for multiple reasons. Core stakeholders in any Citizen Observatory are citizens, scientists, (commercial) data aggregators, decision-makers and policy-makers. The 'enabling environment' category consists of stakeholders who either have a legal mandate or live in the project area. They influence how the activities of the Citizen Observatory are received, thereby enabling or limiting the impacts that the observatory can achieve. In contrast to the core stakeholders, the enabling environment can influence but cannot be chosen by the Citizen Observatory.



Source: Pfeiffer et al., 2016

‘Market forces’ consist of those stakeholder groups that engage in direct economic (financial) transactions with the Citizen Observatory. Internal stakeholders (i.e. often partner organisations in a funded project, see inner circle) are important functional entities in the project or organisation.

Typically, these are staff and managers of organisations, not all of whom are necessarily in favour of the observatory. This approach to stakeholder analysis can be applied in various geographical contexts and social settings and can be used with different types of issues.

– Political, Environmental, Social, Economic and Legal Context Analysis

- Political and legal boundaries: What is the political structure in the observatory area – how many levels of government are there, and how do the various levels affect the CO’s issue? What are defining features, drivers and conflicts of the local political culture? How open is the system to participation? What legislation and regulation at what levels govern the issue addressed by the Citizen Observatory? What laws establish the rights and limits to citizen participation?
- Environmental boundaries: In what landscape does the Citizen Observatory exist: are there defining features in the geography, climate, ecosystems or seasons? What are the ‘natural boundaries’ of the issues investigated by the Citizen Observatory: is it linked to larger-scale phenomena such as river catchments, ecosystems or habitats, weather zones, or migratory species?
- Social/Cultural boundaries: What factors inform the identity of the local population? Is the population homogenous, or are there major ethnic or tribal groups, different languages, or religious, social or cultural sub-groups? Is local culture highly autonomous, or do other cities or countries serve as role models and trend setters?
- Technical boundaries: Are there any specific aspects in the technical infrastructure, such as access to and use of technology, that need to be considered when designing the Citizen Observatory? Are there any particular local preferences for social media networks or popular local online communities?
- Economic boundaries: What is the structure of the local economy, and how is economic power distributed in the project region? Are there major employers or concentrated industrial clusters, ports or special economic zones inside or outside the project area?

– Collaborative stakeholder mapping

Depending on the local context, the Citizen Observatory's issue and how the Citizen Observatory is set up, you may need to identify and engage stakeholders through a collaborative process. This step is particularly important when some but not all core stakeholder types were already identified or engaged during your prior community building process.

Collaborative mapping can be a fruitful way to build on existing networks and the local knowledge held within core stakeholder groups. To tackle this, you will first need to identify which stakeholder types you already have on board. It is useful to define who you will be working with if you have not already done so and ask: *Who will the final community be? Who are the other stakeholders we still need to involve?*

Typically your start point will include a majority from one or more of the following groups:

- **Citizens**, grassroots, bottom up and community groups, and NGO's,
- **Scientists**, academics, professionals across disciplines, technologists, or representation from key scientific organisations, or
- **Policy– and decision-makers**, including local or regional authorities and representatives from municipalities

As you expand your stakeholder groups, there are a number of tools you can use in workshops – or equivalent online environments such as Miro and Mural – to identify stakeholders that are relevant to the context and focus of your observatory. These include Geographic Mapping and Commons Mapping (more on those here).

You may also be interested in:

I want to engage stakeholders...

...by learning how to work with various types of stakeholders

...in ways that keep them motivated over time

I want to engage stakeholders

by learning how to work with various types of stakeholders

Why is it relevant?

Working with a growing group of diverse stakeholders (citizens, scientists, policy-makers, practitioners, etc.) is at the heart of a Citizen Observatory. Yet it can be a real challenge to coordinate communication and activities among all the different groups. This is especially true when the Citizen Observatory is still fairly new and its members do not yet have an established way of working together.

How can this be done?

Finding ways in which to work with all stakeholders within a Citizen Observatory is often challenging. However, there are several methods and tools which can help you to engage with this variety of stakeholders from the start and throughout the lifetime of your observatory.

- Choose and implement a suitable co-design process

A Citizen Observatory brings together (groups of) citizens (often from different age groups, socio-economic backgrounds or political orientations), scientists (including from different scientific disciplines) and decision-makers (civil servants as well as elected officials). A key aspect of working with these various stakeholders means turning separate individuals into a unified group with a shared interest. Choosing and implementing a suitable co-design process can help stakeholders to identify and agree on the common theme they feel passionate about (more on how to suitable co-design approaches here).

Useful Resources

PROJECT REPORT: This **Ground Truth 2.0 report** presents the generic elements of a stakeholder engagement for Citizen Observatories (i.e., to sustainably engage active participants and influential supporters) and shows the tailored strategies of for six Citizen Observatories.

VIDEO: The GROW Insights Workshop held a **meeting and panel** with local and national authorities, policy-makers and decision-makers to explore Citizen Observatories' contributions to the SDGs in Athens.

– Draw up a stakeholder engagement strategy

The different stakeholders of the observatory represent a large number of relevant organisations and individuals to keep track of and work with. It does not make sense to engage all stakeholders with the same intensity. Instead, identify the most efficient and effective approach for each stakeholder. Drawing up an engagement strategy can help to involve, in a sustainable way, the stakeholders that are needed to make the Citizen Observatory successful and to build relationships with the wider society in which the Citizen Observatory operates.

To create an engagement strategy, you can prioritise the stakeholders by distinguishing them according to two criteria: their influence on the Citizen Observatory and their interest in the Citizen Observatory. For example, 'push communication' (one-way communication from the Citizen Observatory, such as sharing updates via email, Twitter or podcasts) is sufficient for low-interest/low-influence stakeholders. Attempts to establish a partnership would be a waste of resources and time. Collaboration and partnership are only appropriate for key players: stakeholders with high influence and high interest who could bring considerable benefits to the Citizen Observatory, but who conversely – if not managed well – would bring considerable risk.

Influence and interest of the different stakeholders are not the only important things; different circumstances and objectives require different approaches. It can be helpful to map the current and envisioned Citizen Observatory members on the Stakeholder Influence Grid (Milosevic, 2003). This matrix maps the level of commitment of a stakeholder, or Citizen Observatory member in this case, against the importance of their support.

BOOK: Citizen Sensing: A Toolkit from the Making Sense project presents a framework, tools and methods in action. See case sStudies "(Amsterdam AirQ" and ") , Commons Mapping Tool".

CoP: The **WeObserve Co-design & Engage Community of Practice** brings together practitioners of Citizen Observatories and citizen science to share and learn different ways of engaging stakeholders in Citizen Observatories.

PROJECT REPORT: Engagement activities and their impacts on policy development. It includes UN FAO slides from one of the GROW MOOCs covering multi-stakeholder soil governance models.

High-commitment and high-importance Citizen Observatory members are 'fully on board'. These 'champions' can be engaged to help drive change, take on specific tasks and take the Citizen Observatory to the 'next level'. Citizen Observatory members with high commitment but low importance are 'strong believers' and are essential for the Citizen Observatory's legwork'. Those Citizen Observatory members with high importance but low commitment are 'conscientious objectors', so the Citizen Observatory's engagement strategy should focus on increasing this group's commitment, for example by means of bilateral meetings and targeted communication. Low importance and low commitment Citizen Observatory members are known as 'cheerleaders'; these people are good for morale but cannot 'win the game' for you.

You may also be interested in:

I want to engage stakeholders...

...by understanding the context and identifying key stakeholders

...in ways that keep them motivated over time

Lessons from the Ground Truth 2.0 Project

While setting up Citizen Observatories in Europe and in Africa, the Ground Truth 2.0 project found that working with the different stakeholders of a Citizen Observatory can benefit from the following:

- *Build mutual relations between the members of the observatory by paying personal attention. Close personal connections at the most local level seems to be most promising. Citizen Observatory participants appreciate it when their names are remembered and they are welcomed and addressed with a personal touch; it has proven useful to invest some time in associating names with faces.*
- *Consider the context and circumstances of the different stakeholders. For example, planning Citizen Observatory meetings after working hours is often valued by citizens who are volunteering their time. This provides a good base to build robust personal relationships with them. Decision-makers prefer to participate in meetings during working hours, so it can be necessary to brief them bilaterally before they will agree to join Citizen Observatory meetings at the end of the working day, together with citizens.*
- *Set up a WhatsApp group (or similar) for the group communication. This is easy and accessible, but also dynamic and informal. This type of communication provides a stronger personal touch than email and can help to cross boundaries presented by the official roles and titles of representatives of public authorities. It also helps to integrate new people in the group; they can become familiar with the group dynamics in a very accessible way.*

– Plan stakeholder engagement over time

While some Citizen Observatories are focused on a local or regional issue, others aim to address a global issue and need to build a movement and active participation at that scale. When this is the case, the engagement strategy should focus on building communities, rather than being a distribution strategy focused on channels and platforms.

Citizen Observatories are powered by participants. It therefore follows that engagement should focus on building communities that support active participation instead of platform - based communities that support passive information spreading. There should be a fundamental link between communication, engagement strategies and participant pathways, and a plan for how these will change as the Citizen Observatory matures.

The plan should respond to the following broad stages:

1. At the beginning of the project focus on using communication through partner channels with social media to raise awareness and encourage participants.
2. Then, as active participation begins, focus communication between participants to build sustainable, active communities.
3. Finally, as the Citizen Observatory produces real results, move to broadcasting only to the participant communities to wider audiences, using the Citizen Observatory's channels and PR activities in mainstream media.

The use of social platforms and traditional media channels are most effective when they tightly focus on achieving the goals of building an active community at the heart of the Citizen Observatory, not building large groups of followers just for the sake of it. Over the last few years in particular, organic reach on social platforms like Twitter and Facebook has made it much harder to meaningfully engage participants.

The GROW Observatory Narrative Design and Storytelling

GROW built its engagement plan around 'circulation', encouraging participation, engagement and knowledge sharing between communities, rather than a traditional 'distribution' model.

Narrative Design is at the heart of the GROW engagement strategy and is linked to research on the drivers for participation commissioned by the BBC in 2006. This report showed that while existing micro-communities were the most important triggers for participation, storytelling plays a crucial role in upscaling, activating large audiences by serving as Catalysts, Instructions and Celebrations.

GROW developed the Narrative Design process to create, curate and amplify stories, developing effective stories for each audience type: grower, policy/advocacy and science and specialist users. This is a user-centred process, building on well-known personas and scenarios, looking at existing behaviour within GROW communities and using this information to make decisions about story formats.

The broad structure for the Narrative Design process is detailed below:

1. *How are stories shared in this community?*
2. *What are people discussing in this community?*
3. *What stories are already being shared by the community on this subject?*
4. *How can we add value to the community?*
5. *How will we listen to the responses?*

Finally, using an open research model, methods, tools and emergent results were iteratively evaluated and circulated as the Citizen Observatory matured over time. GROW developed different ways to circulate these materials to the full range of active participants. These included a programme of Massive Open Online Courses (MOOCs), webinars, focus groups and community gatherings specifically to support peer-to-peer knowledge exchange across 24 communities. Insight workshops were a particularly successful approach to bringing all stakeholders together to share knowledge and results and to enable a more agile and responsive observatory at a large scale.

I want to engage stakeholders
in ways that keep them motivated over time

Why is it relevant?

The success of a Citizen Observatory hinges on the continued engagement of relevant stakeholders. Di erent types of people have different motivations and are drawn to different types of activities in a Citizen Observatory. The key stakeholders in a Citizen Observatory – citizens, scientists and decision-makers – all have different motivations, and these motivations can also change over time.

How can this be done?

Given the diverse group of stakeholders to be involved in your Citizen Observatory, maintaining motivation can be a significant challenge. Fortunately, there are many ways in which you can help keep stakeholders motivated and involved in the process.

- Identify incentives and barriers for engagement

When engaging Citizen Observatory members over time, a major pitfall can be the mismanagement of expectations. If expectations do not align with what actually happens, both during and after the activity, participants might become disappointed, even if the overall experience was not bad. It is therefore good to be aware of possible incentives that can be offered and barriers that may need to be addressed in order to ensure that the various stakeholders remain motivated to participate in the Citizen Observatory.

Useful Resources

PROJECT REPORTS: This **Ground Truth 2.0 report** explains how stakeholder engagement strategies used in different Citizen Observatories in Europe and Africa were based on the incentives and barriers of different stakeholders.

SCIENTIFIC PAPER: This **paper** presents an integrated overview of the incentives and barriers of citizens, scientists and decision-makers relating to participation in Citizen Observatories or similar initiatives.

CoP: The **WeObserve Co-design & Engage Community of Practice** brings together practitioners of Citizen Observatories and citizen science to share and learn different ways of engaging stakeholders in Citizen Observatories.

Example of possible incentives	Barriers to consider and address
Access to raw data and visualised data	Insufficient time and/or resources
Access to the Citizen Observatory community (improving service delivery)	Doubts about the validity of the data
Contribution to the greater good (by addressing the target issue)	Lack of clarity about the Citizen Observatory's objectives, methods, etc.
Learning opportunity to gain knowledge and skills	Need for a critical mass
Increased visibility of the member's organisation	Concerns about the Citizen Observatory's long-term sustainability
Political impact	

*Source: **Anema et al.2018***

- Ensuring the continued motivation of Citizen Observatory members

In general, practice-based experience suggests that the following activities are effective means by which Citizen Observatory leaders and community managers can ensure continued motivation of the Citizen Observatory members:

1. **Develop feedback loops** (about the validity and use of the data),
2. **Recognise** volunteer contributions (in meetings, on websites, in papers),
3. **Train and invest** in Citizen Observatory members,
4. **Provide** clear leadership, structure and organisation, and
5. **Organise** social events for the members.

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...by learning how to work with various types of stakeholders

Lessons learned from the Ground Truth 2.0 project

An analysis of the incentives and barriers for participation in the "Meet Mee Mechelen" Citizen Observatory (focused on air quality monitoring) showed that the citizens, scientists and decision-makers had clearly differing motivations and expectations: the citizens wanted to effect change, policy-makers wanted to collaborate with citizens in innovative ways, and the scientists wanted to gain experience with citizen science in order to move on to new projects. Clashes in their respective incentives systems affected their continued engagement in the observatory.

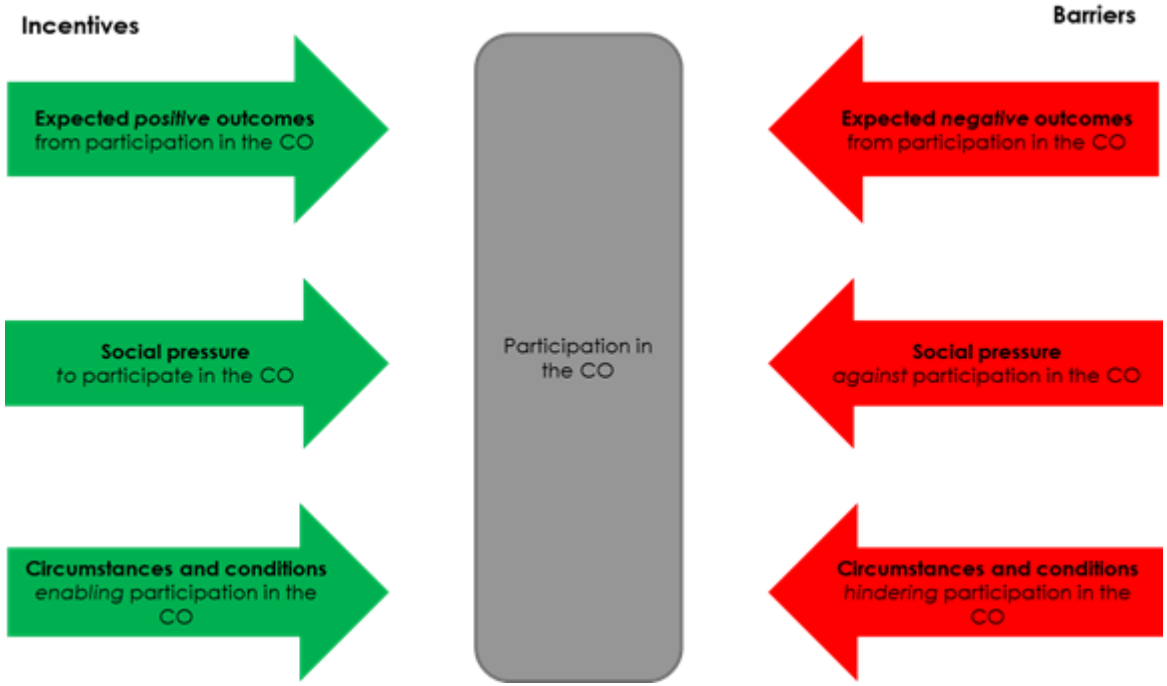


Image: *Ground Truth 2.0*

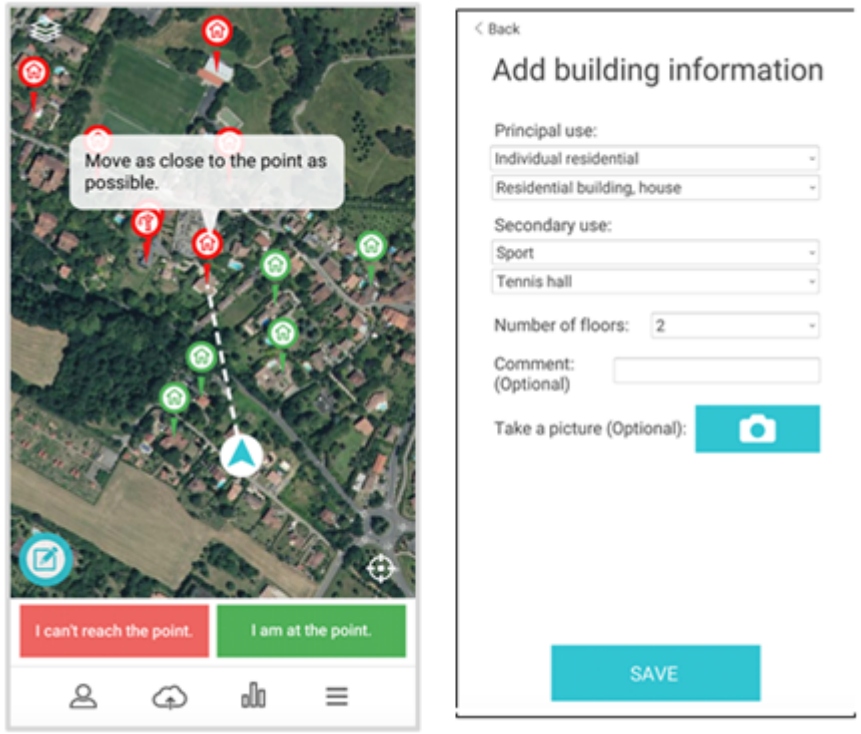
For example, decision-makers were hesitant to share the air quality monitoring results with the public due to concerns about scrutiny and public pressure to act. The citizens were sceptical about the likelihood that their monitoring efforts would make a difference. The key aspect that ensured continued participation of citizens was evidence that the Citizen Observatory's measurement results were being used and were helping to create change: public events were set up to disseminate and discuss the results, and air quality was placed high on political as well as policy agendas. On the other hand, the decision-makers needed to see relations with citizens in the Citizen Observatory shift from perceived 'civil activism' towards collaboration and partnership.

Finally, the scientists involved in this Citizen Observatory were participating on a project basis, rather than for the long run. Their key motivations were to gain experience in citizen science and establish business partnerships that could open doors to new projects in this field. Responding to these different motivations required deliberate efforts by the community managers, including careful facilitation of meetings and steering towards clear agreements among the Citizen Observatory's stakeholders.

Lessons learned from the Landsense project

One of the aims of the LandSense project was to mainstream the use of data collected from Citizen Observatories, as this would contribute to lowering the costs of producing scientific information on land cover and land use. One of the LandSense partners, the French National Mapping Agency (IGN), in collaboration with IIASA, developed the Paysages mobile application (shown below).

The intended participants were the citizens of the city of Toulouse. One of the app's incentives was gamification, and another was its appeal to citizens' altruistic motivations to take part. However, the developers found very little uptake or interest from the citizens. This was partly because the in situ data collection (meaning that participants were directed to specific locations to collect data) required a considerable amount of effort. Even IGN staff testing the app reported that this was an issue. Based on this experience, IGN then changed its approach. It combined armchair-style mapping with targeting authoritative users of the land use land cover product instead of lay citizens, because the former had a vested interest in the product being as up to date as possible. This underlying motivation resulted in participation being much higher. Moreover, since many authoritative users have expert knowledge of land use and land cover, it also meant that familiarity with these concepts was higher. The key lesson learned was to match the motivation for the data collection task with the right stakeholders.



Screenshots from the Paysages mobile app showing locations where data are to be collected (left) and the screen to add building information after reaching the intended point (right)

– Use of Personas and Scenarios

In user-centred and service-oriented design, a 'persona' is a character that represents a potential user or stakeholder, and a 'scenario' is a user story that encapsulates the context, motivation and engagement in an activity.

These concepts can be useful in developing in-depth understanding about core stakeholders and potential service users and their motivations for participating in your Citizen Observatory.

This knowledge can then be used to help guide the identification and engagement of key stakeholders that align with the issue's context and the Citizen Observatory's aims.

Personas and scenarios can be developed from the following steps, and are presented in text through visual materials:

- Desk research and mapping (scoping issues, mapping)
- Feedback (contextual interviews and focus groups), and
- Prototyping (experimenting with ideas prior to developing them).

Personas and Scenarios the GROW Observatory

The GROW Observatory developed in-depth personas and scenarios to help define the stakeholder groups. These were initiated to illustrate the core concepts, motivations and knowledge held by different stakeholder types prior to their joining the Citizen Observatory. An illustration of these stakeholder types can be seen below:

 Juan. 42. Latvia Family Farmer, Rural Business	 Lena. 25. Greece Small holder, Urban, Business	 Tim. 49. UK Land Manager, Urban Civil Service	 Martine. 49. France Education Civil Service
Motivation: I have recently inherited a small family, and I want to optimise the quality of the soil, which has degraded over years due to erosion. It is affecting the quality of my produce, which is also declining, meaning loss of revenue.	**Motivation:** I am an entrepreneur working on a business plan, with innovative USP on provenance. I need access to more land, along with other people who want to start-up businesses. We need information on how to make suitable changes to best manage the land.	**Motivation:** I am a City Park Manager of a municipal park that has an active award winning community garden. I am helping other towns and cities with similar schemes, they need help with soil tests during site selection, basic growing skills and changing land use.	**Motivation:** I am a head teacher of a large city primary school that has a bronze Eco Schools award and active 'Code Club'. We want to bring eco and science experiments together. Our local council wants to set up a GROW sensor competition and campaign for all schools across the region.
Issues: Land Degradation, Erosion, Water Resources.	**Issues:** Land Access. Changing Use, or improving rented land.	**Issues:** Expertise, Land access, Science and Tech. Education and Learning.	**Issues:** Expertise, Land access, Science and Tech. Education and Learning.

Persona and Scenarios in the GROW Observatory

GROW undertook interviews and gathered feedback with different stakeholder groups around issues and concerns relating to soil health and moisture. Stakeholders included policy-makers, and a range of citizens who had concerns about land management, technology, education, health and soil moisture for growing food.

This section partially draws upon the MOOC Citizen Science Projects: *How to make a difference,* though the focus was shifted from citizen science projects to Citizen Observatories.

I want to know what data & knowledge we need
by finding out what exists already

Why is it relevant?

Many previous initiatives may have already addressed questions or problems similar to the ones that you wish to address. They can provide useful examples, a good starting point for your own initiative and research, as well as the opportunity to build on or expand on data and knowledge that are already available, so that you can focus on lling the gaps, not reinventing the wheel.

Where can I find these examples?

While there are now many examples of Citizen Observatories (and similar initiatives), as well as a developed background literature on the topic, there are several ways in which you can find out what data and knowledge exist already. In particular, online search tools provide a useful way in which to begin your search.

- **Past or exiting initiatives & scientific studies**

The process of finding existing examples and knowledge for your observatory should start with a wide search for past or existing initiatives and scientific studies addressing similar topics. First check the state-of-the-art of the discipline by searching for published works in scientific databases such as Google Scholar, Science Direct or Research Gate to be aware of research advances and results. This will provide you with a clear view of the gaps in data and knowledge that can be covered by citizen participation. Knowing the current scientific needs will help you to better identify what data to collect.

Useful Resources

PROJECT REPORTS: From our research into the EU Landscape of Citizen Observatories within the WeObserve project, we produced three reports: a report that outlines **frameworks** which can be used to describe and compare Citizen Observatories, a report on the **insights** from the experiences of Citizen Observatories, and a roadmap report that sets the stage for future Citizen Observatories.

LANDSCAPE REPORT DATA FILE: The 2016 report by the Finnish Environment Institute on Citizen Observatories contained a **database** of all of the Citizen Observatories that they discovered during their survey of the landscape of Citizen Observatories, many of which are still active.

Also find out what data is already available for your research interest. Some global platforms provide specific data that can be useful or complementary for your purposes. For example:

- the Copernicus Information Services offer data from the Copernicus satellites and in-situ components;
- the GEOSS portal is an access point for users seeking global Earth Observation data, imagery and analytical software packages;
- the Global Biodiversity Information Facility (GBIF) provides open access to data about all types of life on Earth, and many others resources exist related to specific topics; and
- the European Open Science Cloud (EOSC) offers an extensive catalogue of resources in which to find data, publications, tools and other resources in Europe.

You may also find it useful to look for resources specific to your scientific field of study, or the environmental issue that you wish to investigate – such as the Citizen Observatories webpage of the network of Marine Protected Areas managers in the Mediterranean (MedPAN).

After this review, you can then also check if an existing Citizen Observatory is currently doing the same as what you had in mind or has been dedicated to the same or similar topics. That way, you can build on their knowledge and/or create synergies with them. Two good places to start searching are the citizen science platforms EU-Citizen.Science (aimed at practitioners) and SciStarter (aimed at volunteers and educators).

DATA INVENTORY: The European Union's Joint Research Commission has compiled an Inventory of citizen science activities for environmental policies, many of which can be considered to be Citizen Observatories.

DATA HANDBOOK: The **Afrialliance Data Collection Handbook** a practical manual focusing on the development sector and the collection of data, mainly by people, and covers the main elements to consider when designing and implementing a data collection project.

CoP: The **WeObserve Co-design & Engage Community of Practice** brings together practitioners of Citizen Observatories and citizen science to share and learn different ways of engaging stakeholders in Citizen Observatories.

You may also be interested in:

I want to know what data and knowledge we need...

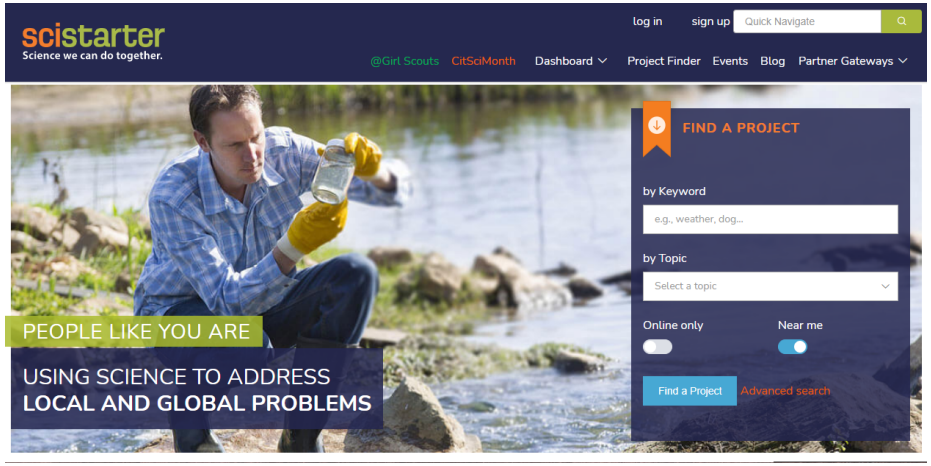
...by deciding what data to collect

– EU-citizen.science

EU-citizen.science is a European platform for sharing knowledge, tools, training and resources for citizen science, funded by the European Union's Horizon 2020 Framework Programme. It contains a database of more than 150 citizen science projects, with descriptions of their objectives, location, keywords and science topics addressed. A link to access the projects' websites and databases is also offered, so you can start searching for similar initiatives here in order to know which data they have produced before. In the platform, you will also find a resources database, with more than 90 entries, training materials and links to more than 100 organisations involved in citizen science.

– SciStarter

SciStarter is a USA-based online citizen science hub where more than 1,500 projects, searchable by location, topic, age level, etc., have been registered by individual project leaders or imported through partnerships with federal governments, NGOs and universities. SciStarter hosts an active community of close to 100,000 registered citizen scientists and millions of additional site visitors. It includes a comprehensive Project Finder that allows searches by location, context, topic, age level, specific characteristics or by any word. The description of the projects is also very comprehensive and links to the projects' websites and responsible organisations are provided.



I want to know what data & knowledge we need

by deciding what data to collect

Why is it relevant?

Deciding what kind of data the members of your Citizen Observatory should collect depends on the issue that your Citizen Observatory wants to address and what data and knowledge is still needed. Moreover, this decision needs to be informed by relevant scientific expertise in order to generate valid and reliable data and results.

How can this be done?

Citizen Observatories are based on citizens observing specific aspects of the environment, sometimes using equipment. For this kind of data, the user's identification, the time and place of the observation, the value of the observation and some supporting material like images, audio recordings or videos for validation purposes are usually collected.

Observations can be as simple as registering a temperature or as complex as taking a lot of measurements as in the RiuNet project, where citizens conduct a complete scientific analysis of several organic and inorganic parameters indicating river water quality. These types of observational data include biodiversity observations, environmental monitoring, meteorological observations, hydrological measurements, land cover mapping and more.

Useful Resources

BOOK: The **AfriAlliance Data Collection Handbook** is a practical manual focusing on the development sector and the collection of data. It covers the main elements to consider when designing and implementing a data collection project.

BOOK CHAPTER: The chapter "Design and development of geographic citizen science: technological perspectives and considerations", in the book '**Geographic Citizen Science Design: No one left behind**' highlights the various impact of information technology on the aims, goals and missions of citizen science and Citizen Observatories.

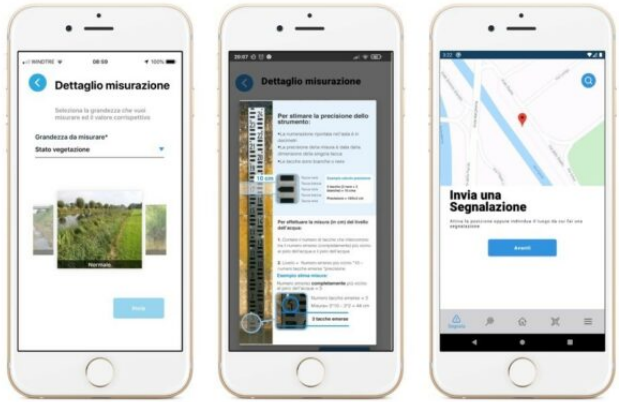
In some cases there is no data collection by validation or interpretation of scientific data, and no contribution to pattern recognition or image analysis. An example is citizens helping scientists to map the ocean trajectories of marine microbes within a simulated web environment (the Adrift project). Another is the annotation of satellite observations or other pictures with what humans can recognise (such as identifying wildlife captured by motion-triggered camera traps).

In particular, Zooniverse is probably the most well-known platform for hosting projects where citizens can participate from their homes, just by using a computer and their time.

Example from the Citizen Observatory of Water in the Alto Adriatico Region

A challenge for water management is the reduction of risk related to extreme events such as floods. Flood management requires the timely provision of early-warning information, particularly in densely populated urban areas. This information depends on reliable water level predictions, created through hydrological and hydraulic models. Yet the performance of these models is often uncertain due to the lack of sufficient observational data. In the Brenta-Bacchiglione catchment area, AAWA has chosen to use the Citizen Observatory on Water to collect complementary sources of hydrological monitoring data to obtain a more spatially distributed coverage, using dedicated apps, easy-to-use physical sensors and other monitoring technologies, linked to a dedicated platform. The crowdsourced water level observations are assimilated into a flood forecasting system: into the hydrological model by means of rating curves assessed for the specific river location, as well as directly into the hydraulic model. This improves the flood forecasting accuracy by integrating physical and social sensors distributed within the river basin, ensuring high model performance (see https://doi.org/10.5194/hess-21-839-2017; https://doi.org/10.5194/hess-22-391-2018).

Other environmental variables, such as the vegetative state of the embankments and the river bed, are important for the calibration of the hydraulic models, and for evaluating the hydraulic roughness along the river. On the other hand, knowing the exact location of the flooded areas during a flood event and the relative water height can be useful both post-event to evaluate and improve the reliability of the model, and during the event to plan civil protection operations. The collection of these data in the Brenta-Bacchiglione catchment area is also entrusted to the Citizen Observatory, being easily identifiable through the use of a dedicated app.



– Devising a data collection scheme

Deciding what data to collect implies that you have identified through a gap analysis what data and knowledge you need and what already exists about the questions you are trying to address (more here on how to find out what exists already).

For each issue (also called 'monitoring theme'), you need to specify the following aspects:

- What needs to be observed,
- Where does it need to be observed,
- How often does it need to be observed,
- By whom, and
- How.

You can answer these questions by creating the following table that actually defines the data model (i.e., the form of each observation). This will help you ensure alignment of your approach and remain focused. It also allows you to keep an overview if your Citizen Observatory needs to address more than one monitoring theme.

In order to define the type of data your Citizen Observatory needs to generate, you should think about the question you are trying to answer.

The parameter to be observed defines what should be collected and can be a list of names to be captured (with their units of measure, e.g. a temperature in degrees), pictures and annotations describing what is being observed.

Scientists can advise you on ***where*** the data needs to be collected (in a limited or in a vast zone, predetermined or random, in the field or from your computer at home) and ***how often*** (e.g. whether repeated observations are needed for the same sample).

You should take into account the ***type*** of information to collect, the sensors and technologies required, and in what level of detail and precision volunteers should collect that data (i.e., to comply with existing taxonomies), while also keeping in mind the implications in terms of personal data collected, the quality of the data and the provision of adequate metadata. The methods that should be employed for the definition of the above mentioned elements depend on the respective application domain and may differ from project to project.

Monitoring theme	***Research question (depending on scientific discipline)***	***Data collection scheme (data model)***				
		Parameter(s) to be observed (what, including measurements, pictures, annotation, etc.)	***Location(s) (where)***	***Frequency of observation (how often)***	***Observer(s) (by whom)***	***Method (how, including the need for instrumentation)***
...	...	...	...	...	...	...

When defining the data collection scheme it is essential to adhere to standardised definitions provided (OGC, INSPIRE, Public Participation in Scientific Research, etc.) in order to facilitate interoperability and combined use with other data sources.

The data collection scheme can inform the metadata describing the data set resulting from your data collections. Deciding on some metadata elements in advance can help you define the more technical aspects of your data collection scheme, such as the desired resolution of the data collected and thus the coordinate reference system used. See more on metadata for managing your data here and for sharing your data here.

The process of creating a data collection scheme can help a community to discuss what should be measured, when, where, how and by whom. Having a map of the geographic area where you would like to collect data allows everyone to pinpoint the location where they can capture data. Another useful tool is a shared calendar, so that everyone can collaborate on the best dates and times for capturing the data.

- Defining instruments and tools

When defining suitable instruments and tools for your data collection, you need to consider the following:

1. **Type of information:** Different approaches require different types of data collection. Sometimes textual information is enough, but other times you may be looking for a photograph, sound or video recording, a physical sample or a digital file.
2. **Technology required:** If observations cannot be reported with only the visual observation of the citizen, a sensor will be needed. A careful selection of the sensor based on the kind of instrument, brands, models, precision and stability should be conducted. Sometimes a DIY sensor could be a possibility.

You may also be interested in:

I want to work with data...

...by collecting data

...by ensuring data quality

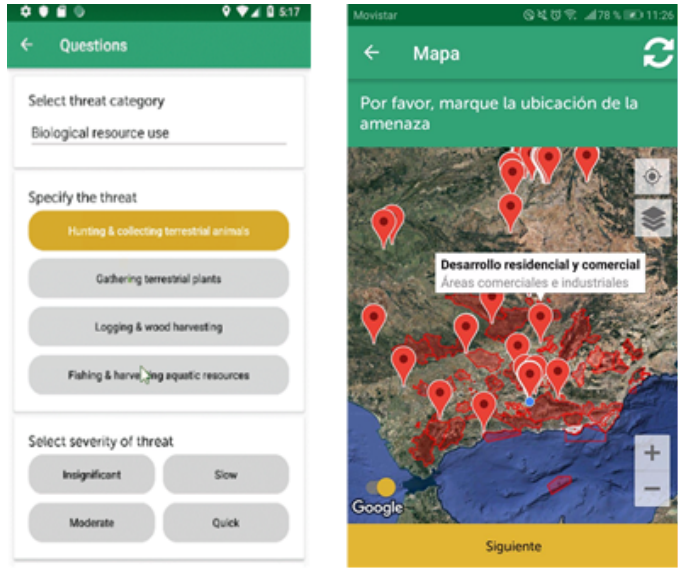
I want to know what data and knowledge we need...

...by finding out what exists already

3. Contextual information and privacy: The data itself should be accompanied by contextual information, such as the date and time of collection, location, observer and conditions

Example from the LandSense project

Working with partner BirdLife International and the associated monitoring organisations on the ground in Spain and Indonesia, the overarching aim was to collect data on threats to bird habitats in areas of importance to birds and biodiversity. The categories of threats were provided by the International Union of Conservation of Nature, so the challenge was to develop a tool for collecting this information on the ground. A simple-to-use menu of threats was embedded in a mobile app (called Natura Alert) to which additional comments, photographs and videos can be added. To render the threat information even more useful, additional questions were asked regarding the longevity and spatial extent of the threat so that these could be linked to the annual threat assessments that are undertaken by BirdLife for each area of importance to birds and biodiversity. The threat data were then made available via the Natura Alert web application, including contextual information such as the location and the date and time of collection.



Screenshots from the Natura Alert mobile app, showing the choices for the type of threat on the ground (left side) and a map showing the locations of other threats (right side).

– Respecting privacy

When you are designing data collection efforts, consider whether you need to have your observers identified and to what extent, ideally limiting the personal data you require from them to the minimum necessary. In any case, you will need their consent so that they can participate in the data collection activities, especially when you also need to collect some of their own personal data.

Also, remember that you may be inadvertently collecting personal data that is not relevant to your research question, such as where people live if they are spotting birds in their backyard or the unique identifiers of their mobile phones. Information like this can be used to identify a specific person. It is also essential to clarify what kinds of legal protections or sharing rights people want to assign to their data when they are contributing photos or measurements. For example, in the Natusfera platform each observer can decide whether their observations and photos are public or private, and whether their geolocation is masked or hidden. More here on how to ensure privacy, especially under the European General Data Protection Regulation, and how to obtain the informed consent of your observers.

- Ensuring data quality from the start

Ensuring that the data collected by your Citizen Observatory are of adequate quality is mainly a matter of keeping processes simple and making sure that sufficient support, clear instructions, well-developed protocols and training are in place. Filtering the options that citizens can report, or using cross-validation mechanisms where some users validate others' submissions, will contribute to a better data set. More on how to ensure data quality here.

I want to work with data
by collecting data

Why is it relevant?

Each Citizen Observatory has its own focus and objectives, depending on the issue it is trying to address. A common characteristic among all Citizen Observatories is that they need data to demonstrate a fact or to illustrate an issue. You therefore need to know how to collect data efficiently and make sure it is scientifically sound, and also what apps and sensors can help you with this.

How can this be done?

Thanks to modern electronics and smartphones, you don't need expensive or complicated scientific equipment to collect data. There are lots of imaginative ways to collect data about the world around you and ways to build your own sensors with a little bit of technical skill. Data collected in this way can still be useful. At the same time, collecting data should be informed by the specific scientific discipline(s) that your Citizen Observatory needs to draw on. This scientific guidance will help identify a data collection methodology that is suitable for the purpose of the Citizen Observatory (incl. app design, devices required, and the location, frequency and intensity of the observations). It will also help you to devise appropriate training for the volunteers. This will vary depending on which environmental issue you are focusing on. It requires the involvement of one or more trained scientists from those fields (more on how to engage key stakeholders here) to design the appropriate scientific methodology that ensures the Citizen Observatory's data will be fit for its purpose.

Useful Resources

TOOL: The **WeObserve Toolkit** includes a wide range of open access tools developed by WeObserve's partners, i.e., four Citizen Observatories: GROW, Scent, Ground Truth 2.0 and LandSense.

TOOL: The **Scent Toolbox** is a set of smart technologies designed to engage citizens in environmental monitoring. Using the Scent Toolbox apps, volunteers collect valuable environmental information. For instance, using Scent Explore, citizens can take photos and videos of changes in the environment and with Scent Measure take measurements of soil conditions.

– Data collection methods

Data collection in Citizen Observatories can be done in different ways. A one-off data collection effort is often called a **'blitz'.** For example, during a water blitz, the intention is to collect as many water quality measurements as possible at one point in time (often on a single day or during one weekend), in a specific region, resulting in a 'dense data cloud'. Apart from the data collected during a blitz, the focused attention and dynamics around this event can also be a good way to attract new participants and citizens, as well as authorities, to your Citizen Observatory (more on building a community here).

Another form of data collection are campaigns, which can last a specific period of time, for example for one or more seasons. Depending on the environmental issue at the heart of the Citizen Observatory, continuous, long-term observations may be required.

Example from the Ground Truth 2.0 project

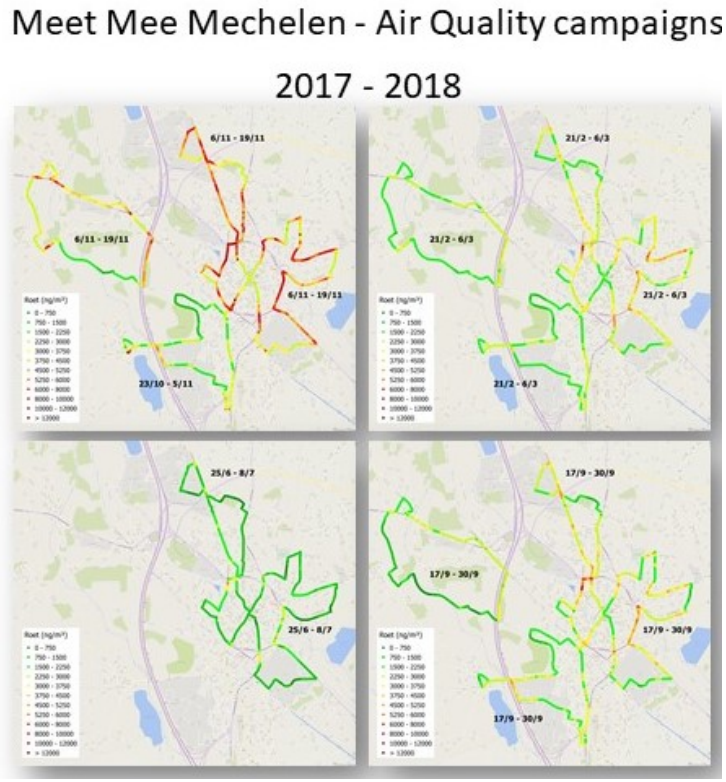
In the Ground Truth 2.0 project, the different Citizen Observatories used different data collection methods. The VattenFokus Citizen Observatory in Sweden undertook 'WaterBlitzes' to collect water quality samples in a rural area (the municipality of Flen) using the FreshWaterWatch Kit and app. More than 50 observations were collected in a single weekend; samples were taken by 39 participants in lakes (55%), streams (25%), ponds, city reservoirs and smaller streams. The aim was to collect as many water quality samples as possible to obtain an overview of the water quality in the water bodies within the municipality. By taking samples of the water quality over a limited period, a snapshot of water quality levels could be generated and conclusions could be drawn about the location of pollution sources. This campaign was paralleled by interviews on national Swedish radio, a feature article in a local newspaper and in the municipality's magazine and website.

DATA SOURCE: Natusfera is one of the largest Citizen Observatory platforms in the biodiversity domain. Participants can register, organise and share all sorts of biodiversity observations, including photo sharing and location.

DATA SOURCE: Wildlife Sightings is a free platform on which to publish, organise and manage the sighting data of birds, insects, mammals, amphibians, reptiles, aquatic, plants.

DATA SOURCE: SPOTTERON is a smartphone app system (Android and iPhone) for documenting localised and specific sightings. The collected data is edited for evaluation and represented on maps.

In the Citizen Observatory "Meet Mee Mechelen" in Belgium, local stakeholders wanted to address air pollution in and around the city of Mechelen. Scientists in the Citizen Observatory designed seasonal measurement campaigns along defined routes. Some 50 volunteers spent 8 weeks in 4 seasons collecting data by cycling through the city with measurement devices, covering a total of 2800 km during 280 hours of observations. They had installed the recommended air quality sensors on their bikes and collected soot observations along the defined routes. Data were collected every 2-3 minutes by the moving sensors and stored as individual data points. This data collection effort resulted in robust data sets for each season and route.



In the Citizen Observatory "'RitmeNatura" in Catalonia, citizens collected phenological data, i.e., about seasonal changes in plants and animals. In such studies, experts and volunteers note the dates in which changes occur in the biological cycles of the species (phenophases), such as the flowering date of the plants or the migratory cycles of birds. Studying the changes in the rhythms of nature provides information about the effects that climate change has on natural ecosystems. This requires long time series that are homogeneous, validated and well spread geographically throughout the country. Moreover, this cannot be done with automatic sensors and instead is based on the periodic observation of the surroundings.

– Toolkits and apps

Data collection in a Citizen Observatory can take advantage of the many toolkits for citizen science, which are multiplying. You can find many both in print and online. Many of these are tailored to people who want to contribute to existing citizen science projects. Toolkits are helpful because they often provide tried and tested ways to reach some of the goals you may have in your Citizen Observatory. Or they provide ready-made platforms for uploading data, which is great if you don't have someone in your Citizen Observatory who can build sensors or data platforms.

To discover toolkits that have been developed for use in various Citizen Observatories, you can turn to the WeObserve toolkit. This Toolkit includes a wide range of open access tools developed by WeObserve's partners, i.e., four Citizen Observatories: GROW, Scent, Ground Truth 2.0 and LandSense, several of which are related to training & data collection for environmental monitoring.

Other sources of tools and toolkits for collecting data are, for example, the CitSci.org platform or the KoBoToolbox. CitSci.org is a platform of Colorado State University in the US which provides tools for the whole research process, from project creation and data analysis to the collection of feedback from participants. For data collection, it provides a Datasheet Creator to create customised datasheets for the projects. The datasheets are made available to the volunteers in the project for print, web, or mobile use. The KoBoToolbox is a suite of tools for field data collection for use in challenging environments, based on free and open source software.

Calibration and technology maintenance during data collection are a common stumbling block. Many different devices help participants collect data and these don't always work the first time. You have to keep an eye on them to make sure they are working correctly. Knowing your sensor before you begin is key. Host a community meeting (online or face-to-face) to introduce the technology, explain how to use it and show everyone how to connect it to the data collection platform.

DATA SOURCE: The **EOSDIS WorldView** app from NASA provides the capability to interactively browse over 800 global, full-resolution satellite imagery layers and then download the underlying data. Many of the available imagery layers are updated within three hours of observation, essentially showing the entire Earth as it looks 'right now'. This supports time-critical application areas such as wildfire management, air quality measurements and flood monitoring. Arctic and Antarctic views of many products are also available for a 'full globe' perspective.

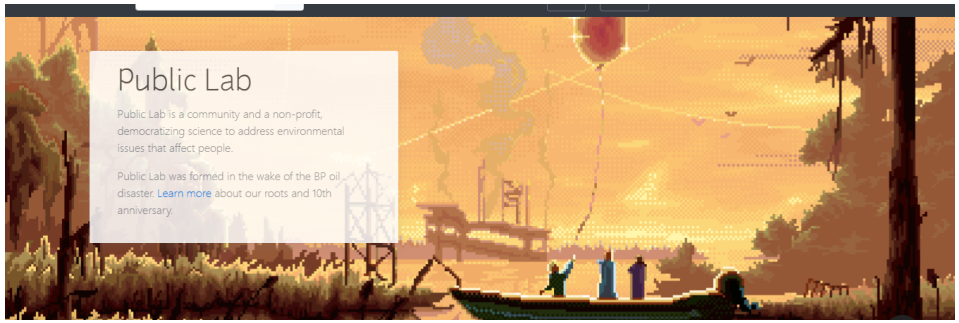
This meeting gives everyone a chance to share their concerns before data collection begins. If possible, invite an expert on the technology so that they can show everyone how to use the sensor, mobile application or platform.

- Simple Sensors and DIY Electronics

Sensors don't have to be complicated! For example, if you want to learn about rainfall, you might build a simple container to collect rain and measure it every day. But there are also more sophisticated experiments you can run yourself with simple equipment.

Example from the Public Lab

Public Lab is a DIY environmental science community who make a variety of toolkits for building simple sensors. They offer a Public Lab Store that sells a great variety of kits for aerial mapping, cameras and infrared photography, DIY microscopes, upgrades & accessories, DIY spectrometry, education kits, environmental emergency response toolkits, environmental sensors and loggers, and much more. The science, technology and data shared on PublicLab.org are community-created and open-source. These tools enable people to collaborate on and build upon community knowledge, and to share data about community environmental health. They focus tool development on creating tools that are low-cost, open-source, easy to use, built through public participation and collaboration, supported by a network of practitioners, and that produce meaningful and understandable data.



DATA SOURCE: ESA SNAP (Sentinel Application Platform). SNAP provides a common architecture for all Sentinel Toolboxes, as well as toolboxes to handle data from other satellite sensors. The different toolboxes implemented for SNAP not only allow users to open, visualise and export satellite data, but they also allow the user to apply different levels of processing, from simple data pre-processing steps to fairly advanced processing chains that can be set up (and batch run) through the Graph Builder tool.

We can build more sophisticated sensors using some DIY electronics. **My Naturewatch** has designed a wildlife camera that you can make yourself using a Raspberry Pi Zero, a USB power bank, and some household objects. **Nature Bytes** has also designed a build-your-own camera based on the Raspberry Pi A+ and Pi camera, for which they have also designed a 3D-printed case. Set either of these cameras up in your garden, and it will capture photos of birds that you could use to understand patterns of wildlife in your local area.

In previous steps, we heard about Smart Citizen and the sensor toolkit that comes ready-made with sensors, including noise, air temperature, light, humidity and air quality. The toolkit connects to an online platform for sharing data. If you have a little more experience with coding, you can even extend it to build your own sensors and experiments.

Example from the Ground Truth 2.0 project

The Ground Truth 2.0 Citizen Observatory in Sweden, called VattenFokus, used the FreshWater Watch platform and app. The FreshWater Watch kit and app can be used to collect data on the causes and the driving forces behind local water quality issues. Simple chemical, optical and visual tests help to collect data on nutrient concentrations, algal blooms, suspended sediment, bank and in-stream vegetation, and hydrological and ecological conditions. There is a mobile app for uploading data and an online portal where collected data is visualised in real time.

The citizens participating in the VattenFokus Citizen Observatory used the FreshWaterWatch kit in 'blitz' style events, where they collected as much data as possible over the course of a weekend. This data is visualised on the VattenFokus platform which brings citizens into collaborations with government, companies, researchers and civil society organizations, all of whom are working together to improve the living environment and the sustainability of Swedish water resources.

– Training observers

Providing tailored training for participants in the Citizen Observatory can be useful to ensure they know how to collect valid observations. This training can be done in the form of face-to-face workshops, online video tutorials or courses, and it can be complemented by extensive training materials on the website of the Citizen Observatory. For example, in the RitmeNatura Citizen Observatory, extensive descriptive cards are provided on the Citizen Observatory website that help in the identification of the species to observe and their characteristics. In the same Citizen Observatory, guided brief courses are offered mainly in schools but also in municipal associations or science dissemination events to train students, teachers and citizens in the observation of the species.

In the COS4Cloud project, webinars have been organised to showcase the development and use of air quality measurement sensors used in the CanAirIO Citizen Observatory. They also offer a video tutorial on their website to learn to build and use the air quality sensor. Other good examples of trainings are the videos provided in the FotoQuestGo Citizen Observatory, which clearly explain how to participate in the Citizen Observatory and how to report the observations. They provide guidance in identification of the land cover and crop types.

To help your participants along, provide supporting resources onboarding kits or sensing manuals. The Citizen Sensing: A Toolkit provides an introduction to many approaches and is a helpful guide for anyone looking to start a citizen science project. The GROW Observatory has also created their own online course on FutureLearn to help growers measure soil moisture and quality. These are just a few examples of step-by-step guides that help citizen scientists use technology and follow data collection processes.

Example form the Citizen Observatory of Water in the Alto Adriatico Region (Italy)

A Citizen Observatory of Water for flood risk management in the Brenta-Bacchiglione River, originating from the WeSenseIt project, uses the COapp to send and share reports regarding: 1) the water level of a river at a section equipped with a hydrometric measuring rod and QR code, 2) the level of the snowpack from a snow gauge equipped with a QR code, 3) the presence of flooded areas including the water height, and 4) simplified measurements of hydrological variables such as the amount of rain and weather conditions, using photographs, videos and other smart ways to identify the phenomenon. To engage and maintain the involvement of 'expert' participants, a set of training courses is run to learn to use the Citizen Observatory supporting technologies, but also to better understand the dynamics of flood events and to acquire high-quality data to feed the models and databases. When an extreme event (i.e., heavy rain) is forecast, AAWA will call upon any available participants to provide data.

You may also be interested in:

I want to work with data...

...by managing data

...by ensuring data quality

...by sharing Citizen Observatory data

...by integrating data from several Citizen Observatories/other sources

I want to work with data
by managing the data

Why is it relevant?

Citizen Observatories generate data that need to be managed in a way that allows for discovering and accessing but also preserving and curating it. Good data management principles and practices maximise the value and benefit of data by ensuring that data remain robust, useful, up to date, understandable and long-lasting for our research purposes and for future uses. This will ensure that data from different origins and types can be integrated into scientific models and eventually generate applications to derive decision support tools.

How can this be done?

You can adopt a set of data management principles for your Citizen Observatory, such as those developed and adopted by GEOSS, to enhance discoverability, accessibility, usability, curation and secure preservation of the data. This involves the elaboration of a data management plan – a time-consuming process that forces you to anticipate required practices and to recognise the need to plan for the resources to put the plan into practice. Below you can find a set of data management principles and practices that will help you to manage your data in the most effective and appropriate way.

- Follow a set of data management principles

The following principles are based on the GEOSS data management principles and are presented here in a tailored version for Citizen Observatory data:

Useful Resources

PRINCIPLES: The **GEOSS Data Management Principles** build on the GEOSS Data Sharing Principles in the sense that they adumbrate what is required in terms of data management to allow data to be promptly shared as Open Data.

TOOL: The **DMP Tool** is a free, open-source, online application that helps researchers create data management plans.

TOOL: DMPOnline: The DMP Roadmap helps you to create, review and share data management plans that meet institutional and funder requirements. It is provided by the Digital Curation Centre (DCC).

TOOL: ARGOS is an open service that simplifies the creation, management, validation, monitoring and **maintenance of** Data Management Plans.

Data discoverability: To make data discoverable, metadata about the data should be elaborated and made public in a catalogue for search engines to find it. Metadata should also state how data should be accessed, used, understood and processed, preferably via formal, structured metadata based on open standards. To avoid losing information and creating confusion, metadata should be produced from the start.

Data access: Data should not be kept in silos but should be accessible via online services, including, at minimum, direct download but preferably user-customisable services for visualisation and computation. Do not wait until your data is perfect. Instead, data should be made available in advance of quality control and flagged in metadata as unchecked. Afterwards, quality-controlled data and the results of quality control will also be shared. The conditions for use, including licenses, should be decided upon and clearly included in the metadata that describes the data. Moreover, the use conditions of sensitive information (e.g. location of endangered species) need to be carefully chosen and indicated.

Data format: Data should be distributed using encodings that are widely accepted in the target user community. The use of open standards will lower the access barrier.

The generation of data should be guided by scientists and eventually exposed in scientific peer-reviewed publications that describe the origin and processing history of raw observations and derived products and their many results and outcomes. During this process, persistent, resolvable identifiers should be assigned to the data.

Acknowledgement: Data contributors should receive acknowledgement for the use of their data if they express a desire for that. Personal information should be kept secure and managed in conformance with the GDPR.

TOOL: easyDMP is a web-service that allows a user to create, share and manage data management plans by guiding the researcher through a set of questions tailored to the recommendations of different funding agencies and research authorities. The resulting document can then be attached to the users proposal.

SCIENTIFIC PAPER: The paper "**Citizen Science 2.0: Data Management Principles to Harness the Power of the Crowd**" addresses the challenges for engaging citizen scientist in the context of research projects.

SCIENTIFIC PAPER: The "**Study on the Data Management of Citizen Science: From the Data Life Cycle Perspective", Data and Information Management**" analyses the lifecycle and data management processes of over 1000 citizen science and Citizen Observatory projects, identifying common themes and best practices.

Curation: Data should be protected from loss and preserved for future use. The cost of preservation should not be underestimated and needs to be planned ahead. If the data curator cannot continue, transfer procedures should be activated.

Data should be periodically verified to ensure integrity, authenticity and readability. Data should be kept up to date in accordance with reviews, and reprocessed as needed.

- Elaborate data management plan

Managing Citizen Observatory data should begin by planning the processes and steps for managing data: from the collection of data; the data model used; the tools needed to collect it; the metadata recorded; the means for storing, sharing and accessing it; and the visualisation, reuse and preservation of the data. You can do this by drafting a Data Management Plan (DMP).

A DMP must also take into account a common issue in citizen science projects: the treatment of personal and sensitive information, which in this case can come from the collection of personal data or the location of people, protected species or private properties. The need for privacy should be flexible, allowing citizens to opt in for programmes that track authorship in the data collection. Authorship is used in quality control estimations or to give acknowledgement for published contributions.

Some useful tools are available to facilitate the creation of a DMP, both for Citizen Observatory data and for other types of data: for example, DMPTool, OpenAIRE ARGOS, easyDMP or DMPOnline, which also includes many real DMPs as concrete examples. Having a DMP in place will ensure that you think about data management-related issues from the start. This way, you will be prepared and know subsequent budget needs.

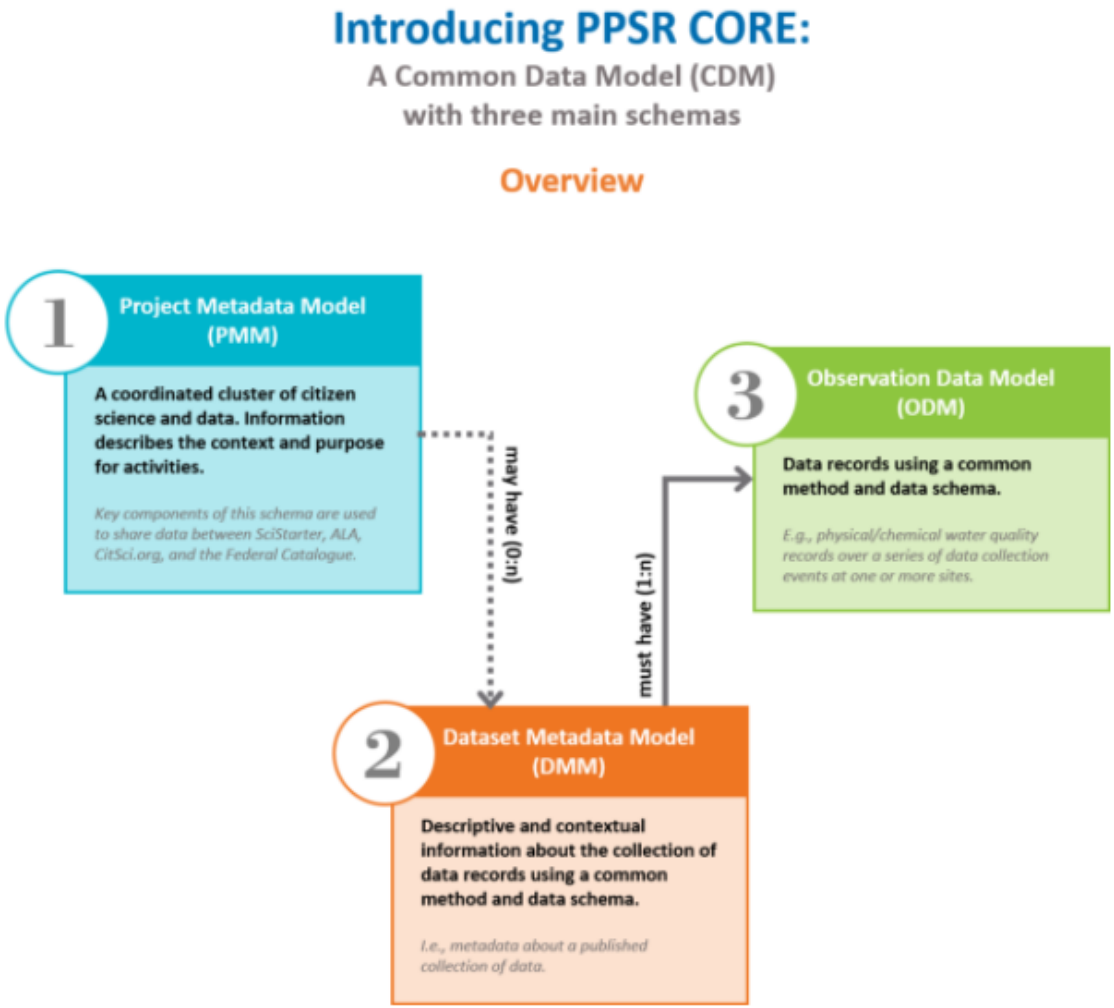
SCIENTIFIC PAPER: The **Advice Note 1 from UKEOF's series of Data Advice Notes** highlights the principles of good data and information management, and suggests policies and procedures for data managers.

STANDARD: The **Data Standard for Public Participation in Scientific Research (PPSR Core)** is a set of global, transdisciplinary data and metadata standards for use in Public Participation in Scientific Research (Citizen Science) projects. PPSR Core is maintained by the Citizen Science Association (**citizenscience.org**) working group for Data & Metadata.

– Elaborate metadata for your data

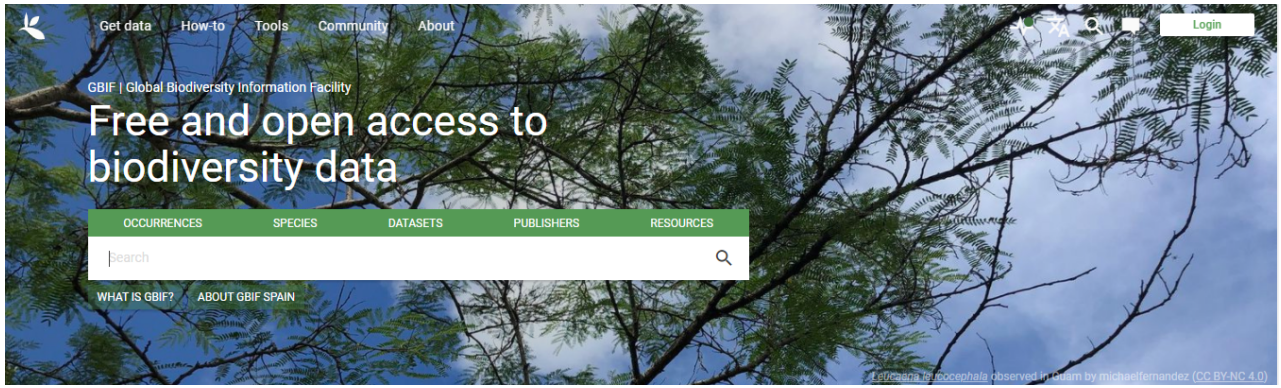
Another good practice in data management is the selection and provision of appropriate metadata for describing data (information about the data). Providing adequate metadata both for the individual observations and for the overall data set will simplify sharing operations and allow data repositories to work together. This also helps scientists to understand the data collected and makes the data usable.

The work done in the Citizen Science Cost Action CA15212 has led to the definition of and evolution of the Data Standard for Public Participation in Scientific Research (PPSR Core), which includes metadata models for describing projects, datasets and observations.



Example from the GBIF initiative

The Global Biodiversity Information Facility (GBIF) GBIF.org is a good example of data management at full scale. Its associated services aggregates data from the GBIF network of participants and publishers (many of them being citizen science initiatives). Their data management rules and conventions support thousands of different datasets drawn from hundreds of institutions around the world. All of the descriptions of datasets in GBIF.org rely on metadata – that is, the information about data – using the open-source EML standard. Each Darwin Core Archive includes as one of its components an EML file. Common standards are the main enabler for bringing together the hundreds of millions of primary biodiversity records in the GBIF index.



You may also be interested in:

I want to work with data...

...by collecting data

...by ensuring data quality

...by sharing our Citizen Observatory data

...by integrating data from several Citizen Observatories/other sources

I want to work with data

by ensuring data quality

Why is it relevant?

A common concern about Citizen Observatories is uncertainty regarding the quality of the collected observations. Many organisations and researchers have been asking: Can citizens provide data that are of the same quality as professional scientists? Learning and implementing best practices on how to define and expose the data quality information will lead to reliable and trustworthy data sets and will minimise uncertainties regarding the collected data.

How can this be done?

Ensuring data quality should be done according to the specific scientific discipline(s) that your Citizen Observatory needs to draw on. This varies depending on which environmental issue you are focusing on. It requires the involvement of one or more trained scientists from those fields; they can help you design the appropriate scientific methodology that ensures your data will be fit for purpose (more on how to engage key stakeholders here).

- Consider key elements of data quality

There are several key elements to ensuring data quality. Apart from the obvious, namely positional (locational) accuracy, other aspects to consider are completeness, consistency, thematic accuracy and temporal homogeneity. The ISO standard ISO 19157 provides a common vocabulary for data quality concepts. It was initially designed for cartography and includes a long list of standardised quality measurements and methodologies. It is also applicable for Citizen Observatories and citizen science.

Useful Resources

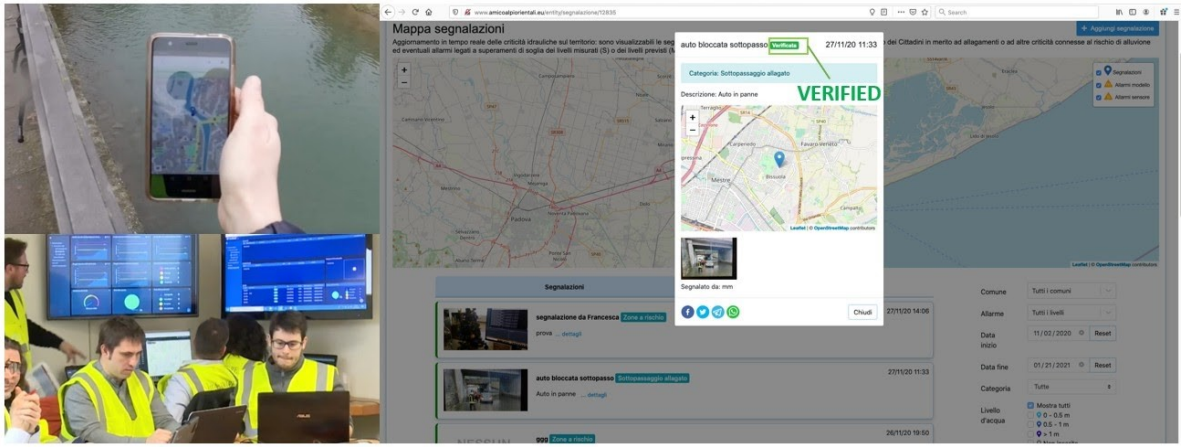
WEBINAR: "Ground Truth Week 2019 – Webinar 3.2 – Data quality and interoperability" describes the capabilities of the quality tool developed in Ground Truth 2.0 and demonstrates how to use it in a real-life scenario.

BOOK CHAPTER: "Chapter 8 Data Quality in Citizen Science" in the book "The Science of Citizen Science" discusses the broad and complex topic of data quality in citizen science and how we can ensure the validity and reliability of data generated by citizen scientists and citizen science projects.

WEBSITE: QualityML is a dictionary based on the ISO19157 that contains hierarchically structured concepts to precisely define and relate quality levels: from quality classes to quality measurements.

Example from the Citizen Observatory of Water for flood risk management in the Brenta-Bacchiglione catchment (Italy)

In the Brenta-Bacchiglione Citizen Observatory, authorities must be able to manage variable quality of information (e.g. crowdsourced observations regarding the water level of a river), in order to have access to an accurate and consistent data set to be taken into account for decision-making purposes. In the data management platform, automatic filters provided for validation operations are also integrated with 'manual' control systems to be used if necessary. Information reported, such as the presence of flooded areas, are published on the platform as "verified by the authorities" only if confirmed by a certain number of reports or by a Civil Protection team sent to the specific location.



You may also be interested in:

I want to work with data...

...by collecting data

...by managing data

...by sharing Citizen Observatory data

...by integrating data from several Citizen Observatories/other sources

I want to generate insights results from data and knowledge...

...by visualising & interpreting data

...by analysing data

– Improving data reliability

Data reliability (or replicability) is about whether you can get the same results when you repeat an experiment or observation. For example, suppose that you see a bird and identify that bird as a robin. At the same time, someone else sees the same bird and comes to the same conclusion.

The data is reliable because multiple observations have given the same result. The participation of many observers in your Citizen Observatory with different degrees of expertise can be compensated by taking advantage of expert contributors who can review the observations of others.

When citizens use inexpensive or DIY sensors connected to smartphones, there are also concerns about data quality and stability of the measurements. In the sensor.community initiative, citizens are encouraged to regularly collect data close to official stations as a way to estimate the bias and degradation of low-cost sensors and to ensure compatibility with official sources.

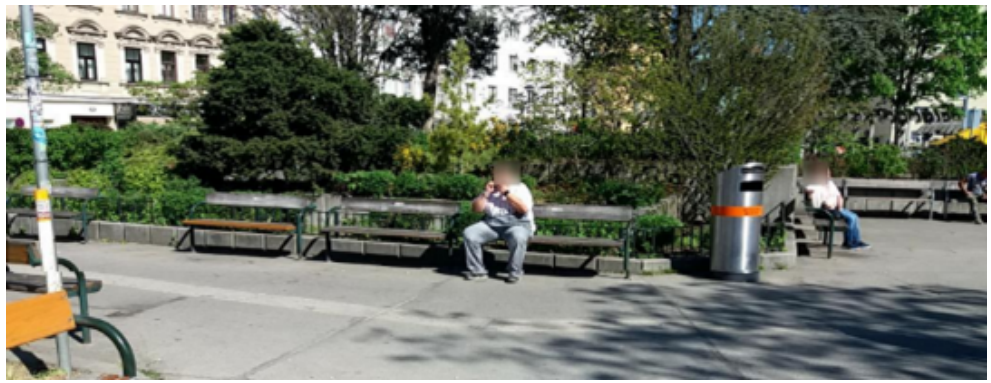
A lack of citizen expertise can also be mitigated by providing comprehensive and focused training for new participants in the Citizen Observatory in order to ensure they know how to collect valid observations. This training can be done in the form of face-to-face workshops, online video tutorials or courses, and can be complemented by extensive training materials on the website of the Citizen Observatory.

Data quality at the observation level can also be improved by providing well-designed data collection tools that minimise the chances of data collection errors. For qualitative values, multiple-choice selectors can be provided instead of free text inputs. For quantitative values measured by soil and air temperature sensors, values outside of a predefined range can be considered wrong and eliminated before allowing values into the system storage.

Example from the LandSense project

LandSense also uses a quality assurance system to make sure data collected for land cover detection, agricultural monitoring and habitat monitoring campaigns are 'clean'. First, the system checks for overlaps in areas drawn by users and flags them so that users can correct them. Next, the system looks for problems with photographs. Many citizen science projects have mobile apps that ask citizens to take photographs as part of the data collection process, but this can create issues of personal privacy. For example, faces and license plates are automatically blurred out to comply with the EU General Data Protection Regulation (GDPR). Photographs are also checked to make sure they are not too dark or blurry. Next, the service checks for position accuracy, using mobile phone GPS to make sure an observation is geographically accurate.

It also checks against reference data from a 'gold standard' data set produced by professional scientists to make sure there is an overall agreement and that nothing is omitted or entered incorrectly. Finally, the service compares answers from the same location given by multiple contributors to provide a level of confidence in the data.



Example of a photograph from the CityOases mobile app with blurring from the LandSense quality assurance service applied to faces

Reliability in Machine Learning

Common examples of non-reliable data are observations provided by uncalibrated sensors (instrument biases) or human misinterpretations, but reliability problems can also emerge in artificial intelligence. In the Scent project, citizens are guided to areas where there is a need for environmental information. In those locations, they collect images of land cover/land use. Images can be submitted to the ScentIntelligence Engine (SIE); a tool that uses machine learning to automatically detect land cover types and objects in an image according to Scent's taxonomy.

The system works by assigning a score to each annotation tag. If the score is high enough, the annotation is considered valid. If not, the image is redirected to Scent Collaborate, where citizen scientists manually annotate the images.

– Assessing data validity

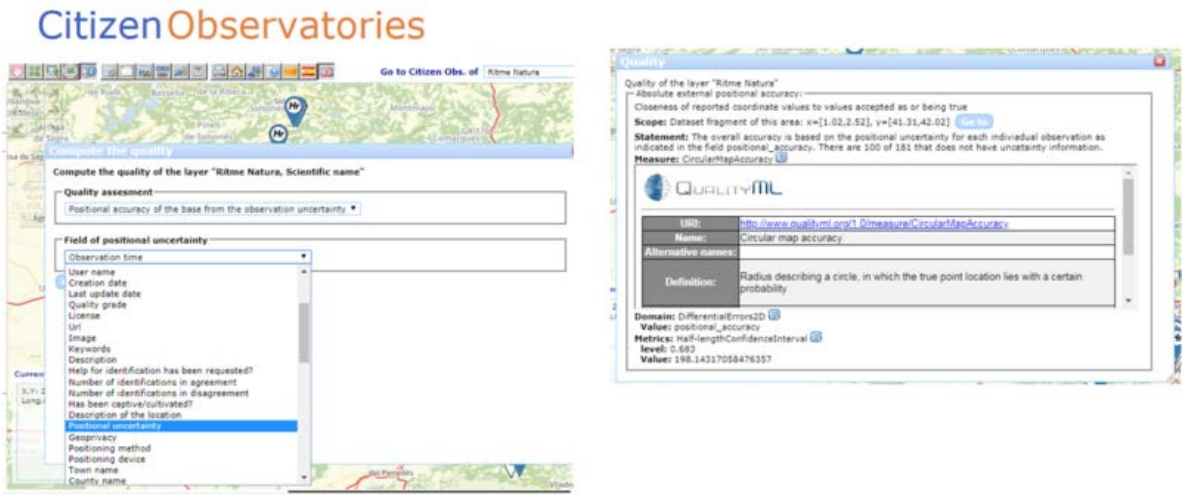
Data validity assesses how credible or trustworthy the data are. The collected data are valid if they accurately represent the real world. For example, suppose you measure air quality using a low-cost sensor, but it has not been correctly calibrated. When such observations are integrated, we can provide a data validity indicator for the data set.

In dynamic data sets that are constantly updated, data quality has to be constantly assessed. It is currently accepted that data quality should be based on the 'fit-for-purpose' concept. In addition, Citizen Observatories' data will be used in combination with other data sources. That is why it is recommended to provide the necessary tools for estimating the components of data quality and to allow comparison with other data sets.

Example from the GroundTruth 2.0 project

In the Ground Truth 2.0 project, we developed a set of quality measures that can be applied directly in the Citizen Observatory data set while being visualised. The result of the quality assessment is presented in a standard form and associated to the QualityML vocabulary.

The quality assessment can be shared with other users of the data set.



- Consider User Reputation

  An observer rating scheme can be used to allow the system to judge the citizen's data quality. A numbered score increases or decreases depending on the quality of the measurements that the citizen has collected. Each observer receives a score for each collected measurement. If a measurement is evaluated as faulty, points are deducted, decreasing the citizen's total score that indicates how trustworthy their observations are.

- Relying on user feedback

  User feedback about data can also be a good source of quality estimation. Another way to know about the quality of the observations is to register users' experiences while they are using the data. One tool for allowing this user interaction is the NiMMbus platform; this is a reference implementation of the OGC Geospatial User Feedback standard.

I want to work with data

by sharing our Citizen Observatory data

Why is it relevant?

Administrations in many countries have already embraced open data. For them, open data helps to facilitate transparency, accountability and public participation. For scientists, open data enables studies aiming to understand global problems such as climate change and helps to solve problems such as disease, crime or famine. Computer engineers can also benefit from open data sources as inputs for machine learning training. Many Citizen Observatories are even obliged by their funders to share their data as part of the data management policies.

How can this be done?

In sharing data, there is no single solution that suits everyone. Some users will simply need to see the data, while others will need to analyse and combine it. The open data movement suggests different steps that you can gradually pursue.

- Ensuring data discoverability

As the number of citizen-generated data is constantly increasing, it also becomes more and more important to ensure that the data is easily findable, accessible, comparable and re-usable in the future. These are the so-called FAIR data principles (Findable, Accessible, Interoperable, and Reusable). Data are made well-findable by describing them through metadata that includes descriptions, responsible parties, history and data quality, as well as a clear description of the data models. Metadata is commonly shared in centralised metadata catalogues. In contrast, data is made open and accessible by the interactive service provided by each Citizen Observatory.

Useful Resources

WEBSITE: **WeObserve marketplace** contains several openly accessible data sets produced by LandSense, Ground Truth 2.0, Scent and Grow projects. This website concentrates the work done by thousands of citizens during the duration of the project activities.

VIDEO: **Creative Commons: Wanna work together** in the **Creative Commons** website illustrates the need for open licences. In the website, CC licenses are described and can be selected based on the need to provide attribution, allow commercial use, permit derivative works, etc.

Good intentions should also be complemented by good planning and practice or the consequences are that, in practice, data may become unavailable when the project concludes. See the video: FAIR Data in Trustworthy repositories: the basics

- Licensing your Open Data

The first thing to take into account is that data sharing does not mean giving up your intellectual property. To secure the intellectual property and still allow others to freely and openly use the data, a first step is to select an appropriate data licence. It is important to select a licence that has clear wording which it is easy to interpret. Creative Commons provides a short list of standard licences that can be reused and applied to data resources. The use of a limited number standard licences is fundamental in the creation of integrated products that combine datasets from several origins. If licences differ too much, the resulting product will inherit the restrictions of all licences, creating a result that is too restricted and which will hinder openness.

- Making your Open Data accessible

Once the data licence has been selected for the Citizen Observatory, the next step in making it public is to present the data as files in a project website or in open repositories (such as Zenodo). But there are many formats and many data models that can be used. It is important to accompany the data with metadata that describes the data that were collected as well as the data model (what the observed values mean). By distributing the data in a format that is based on an open standard and easy to use, we prevent misinterpretation of the data and facilitate their usage. These files can be accompanied by code to analyse the data (as done by GROW, using Github to share and provide their analysis code on soil moisture for crop growing in Portugal using Python Jupyter Notebooks). In the big data world (where distributing files becomes impractical) it is even better to provide a service that gives access only to the part of the data that users really need.

REPORT: The **"OGC Citizen Science Interoperability Experiment Engineering Report"** describes the first phase of the Citizen Science (CS) Interoperability Experiment (IE) organised by the WeObserve Interop CoP and provides examples on data sharing standards applied to Citizen Observatories.

FAIRsharing: FAIRsharing is a community-driven resource with a growing number of users, adopters, collaborators and activities, all working to enable the FAIR Principles and to make Standards, Knowledge Bases, Repositories and Data Policies FAIR.

Examples of good and useful services that implement common standards approved by the Open Geospatial Consortium are SOS (Sensor Observation Service) and the SensorThings API. Both fall under the Sensor Web Enablement umbrella, and both allow scientists to retrieve sensor and time-series data filtered geographically, temporally and by data type in JSON or XML format.

Some global platforms where you can share your data:

- The GEOSS portal is an access point for users seeking global Earth Observation data, imagery and analytical software packages;
- The Global Biodiversity Information Facility (GBIF) provides open access to data about all types of life on Earth;
- The Ocean Biodiversity Information System (OBIS) is a global open-access data and information clearing-house on marine biodiversity for science, conservation and sustainable development;
- Many others exist related to specific topics (such as https://scistarter.org/ and https://www.zooniverse.org/). The European Open Science Cloud (EOSC) offers an extensive catalogue of resources on where to find data, publications, tools and other resources in Europe.

Ground Truth 2.0, Scent, GROW and WeObserve set up Citizen Observatories that applied these standards and improved data sharing. To allow for the integration of the observations into new models and applications, Scent implemented the Harmonisation platform that later became discoverable through the GEOSS Portal, where Earth Observation data from all over the world can be searched. A combination of shared solutions can cover the needs of more users. Many citizen science data platforms, such as iNaturalist or Spotteron, offer an export to CSV files for occasional downloads, as well as open APIs to create a permanent connection to the data.

You may also be interested in:

I want to work with data...

...by collecting data

...by managing the data

...by ensuring data quality

...by integrating data from several Citizen Observatories/ other sources

I want to generate insights & results from our data & knowledge...

...by visualising and interpreting the data

I want to achieve impact with the Citizen Observatory results...

...by adopting open data policies & data standards

Example from the Landsense project

In LandSense, we use the LandSense Engagement Platform to openly share data. We use a distributed system for this. The data from the different citizen science campaigns are hosted with the various project organisations but are accessible on the platform. This also helps to ensure that access to the data can be sustained beyond the lifetime of the project. Landsense data is also uploaded to Zenodo and Pangaea for data access and data preservation purposes. The paper "Global dataset of crowdsources for land cover and land use data" illustrates most of the good practices necessary for data sharing. The license is specified as a Creative Commons 3.0 resource. It uses the CC-BY squema and allows any possible usage, including commercial, the only requirement being the need to acknowledge the data sources. The data is accompanied by some medata representing the spatial-temporal context. To access the data, a series of easy to download ZIP files are provided.

These zips contain a text data structure that uses tabular data. This data service does not allow for easy extraction of a subset of the data, but given the amount of data contained in the zips, this should not be necessary.

- Ensuring privacy

When it comes to data sharing, a very important topic for Citizen Observatories is compliance with the new EU legislation on data protection and privacy of individuals, the so-called GDPR (the General Data Protection Regulation of the EU, more about that here). Collection of personal data should be kept to a minimum, user consent should be obtained, and all shared data should be anonymised and compliant with EU regulations.

At the same time, Citizen Observatories are collaborative efforts that stimulate individuals to continue activities as long as their time and efforts are recognised. For example, citizens should be notified when their observations become part of a scientific study or a governmental report. If they request attribution (e.g. by means of a CC-BY licence), contributors should be named as co-contributors in any derivative work done with the data.

Integrating available resources with mechanisms like these and leveraging their data management principles gives us a simple way to deal with open data obligations and to access research data across different disciplines while also promoting the use of open solutions and common standards for data sharing.

I want to work with data

by integrating data from several Citizen Observatories/other sources

Why is it relevant?

Some Citizen Observatories have regional and global coverage and impact, but these are the exception. Most commonly, Citizen Observatories engage a limited set of stakeholders and are localised in space and time, often focusing on a single topic. To generate a comprehensive overview of the issue and meaningful insights about your data, it is useful to combine variables and data from different Citizen Observatories and other citizen science projects in a single representation.

How can this be done?

Data integration can be achieved by merging data from several projects into a single data set. However, this is only useful if the data are about the same issue (e.g. biodiversity spotting) and are collected in a semantically compatible way. A perfect example of such a centralised and systematic data collection system is that of the Global Biodiversity Information Facility (GBIF). The data compiled here are provided by many institutions and citizen science projects from around the world. GBIF's information architecture makes these data accessible and searchable through a single portal. Data available through the GBIF portal are primarily distribution data on plants, animals, fungi and microbes. Two elements are key for this integration. The first is that a common set of scientific names and taxonomies has been adopted by the data sources (e.g. iSpot, iNaturalist, Pl@ntnet, etc). This common taxonomy ensures that data from different sources has the same meaning and can be mixed together. The second element is an API provided by GBIF that facilitates data flows between the biodiversity Citizen Observatories and GBIF. This allows for the regular and automatic updating of the centralised dataset.

Useful Resources

WEBSITE: The data from **Ground Truth 2.0 Citizen Observatories** is presented here in a single map that uses OpenStreetMap as a background and **MiraMon** technology as an engine.

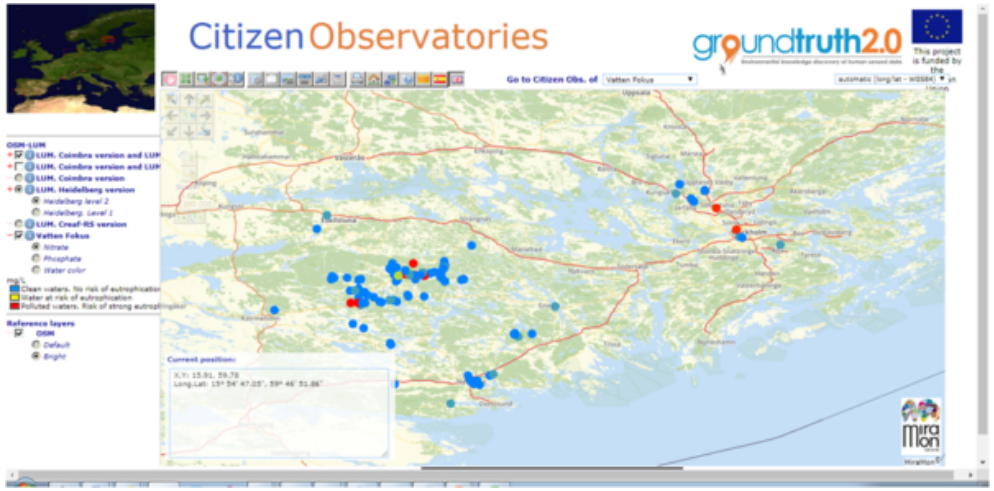
POLICY BRIEF: This **policy brief** suggests a path toward the implementation of a shared computer infrastructure. It also recommends common services (e.g. authentication) that facilitate the efficient management of European Citizen Observatory sources, by making them reusable by current and future Citizen Observatory communities as well as making the activities and outputs of the communities visible in GEO.

Data integration can also be done in an ad-hoc way. In this case, data is maintained in the original sources (the Citizen Observatory data services) and is presented together in a single view for comparison or analysis. This requires that users make the effort to interoperate with the data source using a tool that is able to do the integration on-the-spot.

The Open Geospatial Consortium (OGC) and the WeObserve project are working on developing best practices on how to apply existing OGC standards for citizen science.

Example from the GroundTruth 2.0 project

In the Ground Truth 2.0 project, seven observatories in six countries (Zambia, Kenya, Sweden, Spain, Belgium and The Netherlands) generated observations about biodiversity, natural resources, water management, water quality and air quality. The information from these observatories was presented together in a single map browser, using the OpenStreetMap data as a background. This enabled the complete set of observatories from a single point to be told in one comprehensive story.



The various Citizen Observatories and citizen science initiatives in place have led to the creation of a rather fragmented landscape of repositories, each with their resources available under different models, standards and technologies.

In an effort to avoid silos of resources, the Global Earth Observation System of Systems (GEOSS) offers a single access point to Earth Observation data, connecting users to various environmental monitoring systems around the world while promoting the use of common technical standards to support their GEOSS (see Portalwww.geoportal.org).

Similarly, the European Open Science Cloud (EOSC) provides a virtual environment and a marketplace with open and seamless services for storage, management, analysis and re-use of research data. The Cos4Cloud project is developing and integrating the eleven services and resources in the European Open Science Cloud (EOSC) ecosystem, so that any existing citizen science observatory will be able to choose and install the technological services needed to improve its functionalities.

You may also be interested in:

I want to work with data...

...by collecting data

...by managing the data

...by ensuring data quality

...by sharing our Citizen Observatory data

I want to generate insights and results from our data and knowledge

by visualising & interpreting the data

Why is it relevant?

It is important that you can deliver a clear message to stakeholders and/or policy-makers in order to affect the changes that your Citizen Observatory suggests. Creating engaging visualisations is one effective way to do that.

How can this be done?

"A picture is worth a thousand words." This old saying also applies to Citizen Observatories, where data visualisation can help you and your participants to explore and understand data and to communicate results quickly and in an engaging way. Nevertheless, when it comes to extracting meaningful information from data and interpreting the data, scientific knowledge may be required so that the interpretation is accurate and meaningful. Data visualisations, besides communicating results, can also be used as a tool for data interpretation by helping to detect gaps, errors or inconsistencies in your data sets.

- Types of data visualisation

  Visualisations come in many forms, such as hand-drawn scribbles, complex digital imagery, or multidimensional, interactive applications. It takes both visual and scientific skills to create useful visualisations. Remember, the purpose of visualisations is to tell a story that will affect your audience and encourage them to make the changes that your data is suggesting. The visualisations need to tell the story accurately. At the same time, they need to be interesting enough to hold your audience's attention.

Useful Resources

▶ **WeObserve MOOC, enrollment is now open:** The online course **Citizen Science Projects: How to make a difference** on FutureLearn addresses data analysis and visualisation in depth, including many examples, discussion of biases in data visualisation, and data sets for you to experiment with.

▶ **VIDEO: "How we did it: Visualising Data "** provides more examples of data visualisations from four Citizen Observatory projects.

TOOL: WeObserve Toolkit for data quality and visualisation is a selection of tools that can help you with all aspects of citizen-generated data management, including validation, analysis, quality assurance and visualisation.

As noted, the visualisation is only part of the story; you will need to interpret the data to place the correct emphasis on the parts of the visualisation that you want to have stand out to the audience. If this expertise is not available among the stakeholders and actors within your Citizen Observatory, you may need to engage experts that can support you with data interpretation and visualisation (more on how to engage key stakeholders here).

However, with some training, every citizen scientist can learn to use data visualisations as a means to interpret and check their own data sets. Here is the reflection from a participant of the WeObserve online course, after finishing a training module on data visualisation:

"After last week's module, I have been working on the way I visualise my data. In my online blog this week, I have included the new charts I produced because of your course ... Because of the visualisation, and how to make the data more meaningful, I discovered some errors in the data records, but also it has identified a weather anomaly, where the last week of June over many successive years has been colder than the weeks either side. I have no explanation for this. Going back into the actual station records, it isn't incorrect tabulation, there is clearly a trend for this 7-day period to be cooler, over successive years. Curious!" (Norman Woollons, Learner)

Two very common types of data visualisations are:

- **Time-series graphs:** These usually show how a variable changes over time. The data on these graphs can be historical from observed and measured data, or future projections based on simulations. Historical time-series graphs can also be based on simulations.

- **Maps:** These show information and data in relation to a specified system of reference. Two or more variables are plotted against each other. Standard maps combine geological and infrastructure information (such as topography and street maps) with a geographic location; but you can map any information that has a location based on the geographic coordinate system (latitudes and longitudes).

TOOL: The **Data Postcard tool** is designed for community members and citizen science

practitioners wanting to share the data they collect. It is a creative way to visualise and share data from a citizen science project.

Data visualisation applications:

- **Matplotlib**: For those of you with programming experience, Matplotlib is a popular choice for data visualisation and can be easily integrated into Jupyter notebooks.
- **Leaflet**: Leaflet is an open-source JavaScript library for mobile-friendly interactive maps. It works efficiently across all major desktop and mobile platforms, can be extended with a variety of plugins, and is well documented.
- Other free tools: **Grafana**, **Rawgraphs**, and **Apache Superset**

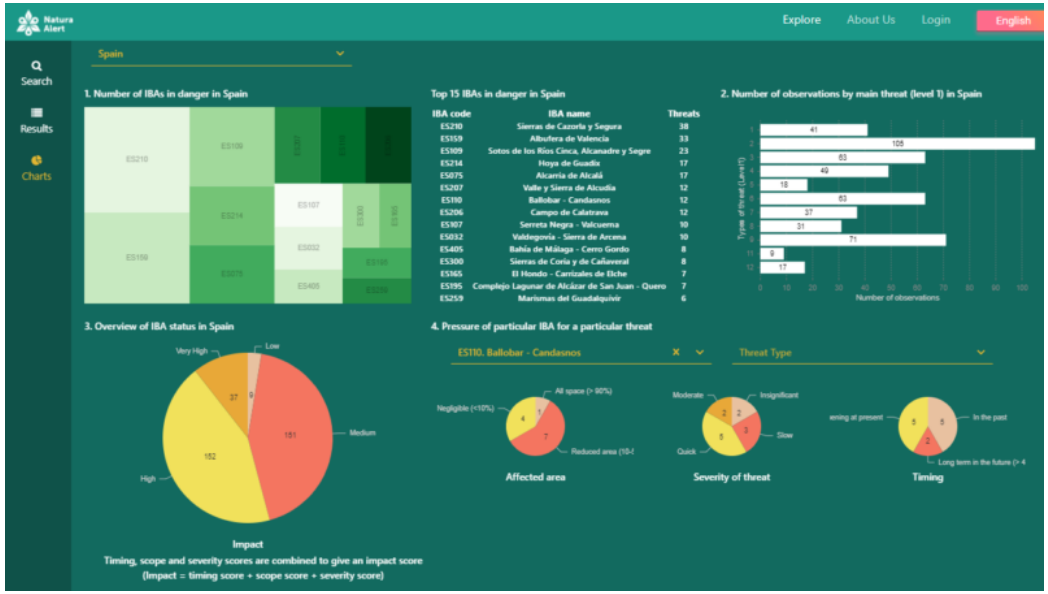
There are other ‘maps’ based on different reference systems (like the weekly mood map, or mapping a person’s mental state while performing an activity related to a perceived challenge and the person’s skill level).

There are other ‘maps’ based on different reference systems (like the weekly mood map, or mapping a person’s mental state while performing an activity related to a perceived challenge and the person’s skill level).

Sometimes these two graphs are combined to produce an interactive experience; clicking on the map might display a time-series graph at that location.

Example from the LandSense project

The Natura Alert app was developed by the LandSense Citizen Observatory to report threats to bird habitats in Important Bird and Biodiversity Areas (IBAs). Using Natura Alert, volunteers in the BirdLife network in Spain have collected threat information, which can be visualised on a map displayed in the Natura Alert web application. The data collected for Spain can also be summarised in a dashboard of charts available in the web app as shown in the figure below. This allows users to see the main habitat threats in Spain as well as by IBA. As more data are collected, these graphs will change dynamically to reflect the current situation.



You may also be interested in:

I want to generate insights & results from our data & knowledge...

...by analysing the data

I want to achieve impact with Citizen Observatory results...

...by communicating the Citizen Observatory results effectively

– Mapping and visualising location-based data

There are many tools available to map location-based data and visualise it easily. Some cost money, such as Tableau, PowerBI and Spotfire; others are free, such as Grafana, Rawgraphs and Apache Superset. With these, you can quickly produce a map like this one and also quickly see if sensors are out of place (i.e., in the ocean). Sharing a graph like this with participants can encourage them, as they can see the progress of the project.

This visualisation shows the location of GROW sensors and the data from one sensor. However, it shows the importance of interpreting the data and the need for relevant scientific experience. For instance, on the temperature and moisture graphs there are straight lines – what can these mean? In this case, it means that data is missing because the battery died on the sensor. Also notice the patterns in the moisture levels – what do these indicate? Someone with the necessary scientific expertise could interpret these graphs and, more importantly, compare them with graphs from other locations to draw conclusions on soil moisture.

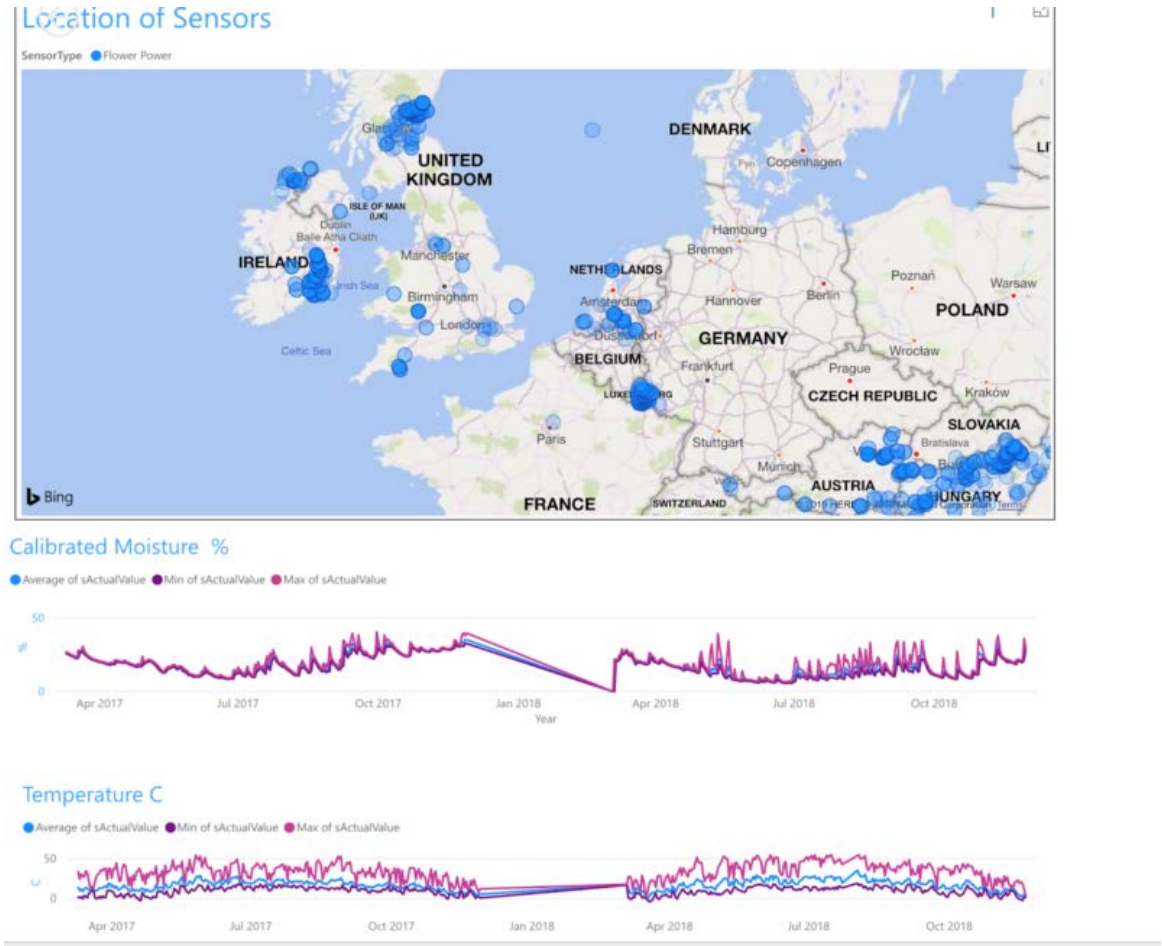


Image: The GROW Observatory map of soil sensors across Europe

– Data visualisation in a simple and personal way

The Data Postcard Tool is a creative way to visualise and share data from a citizen science project. It is designed for community members and citizen science practitioners who wish to share the data they collect. It can be used to illustrate something simple, like the amount of times you walk through an area with high air pollution over the course of a week, or the kinds of animals you have observed in a prescribed area. This tool is designed for participants in a citizen science project, and no previous experience of data visualisation is required.

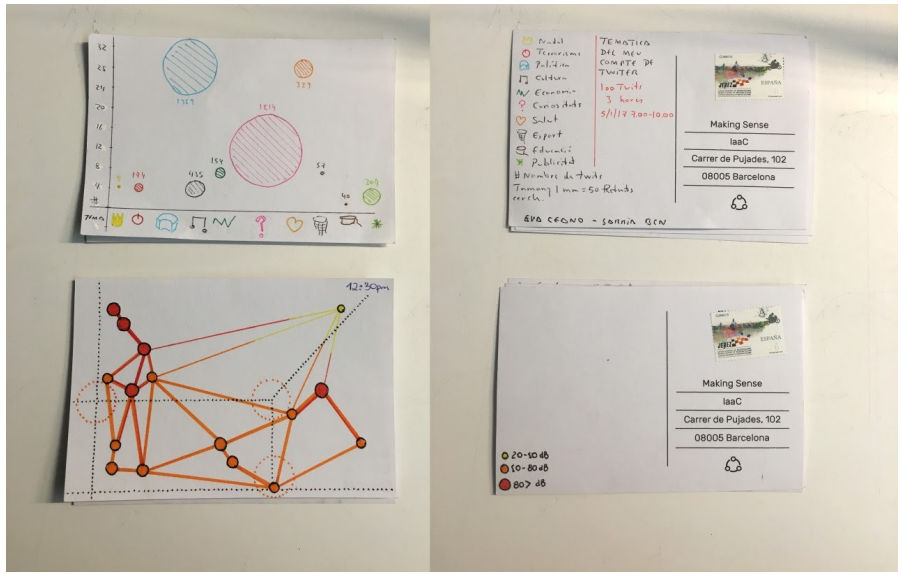


Image: Data postcards from Making Sense project

This section partially draws upon the MOOC: *Citizen Science Projects: How to make a difference*, though the focus was shifted from citizen science projects to Citizen Observatories.

I want to generate insights & results from our data & knowledge **by analysing the data**

Why is it relevant?

Your Citizen Observatory is fully up and running and you are collecting lots of data. Now you need to translate these data into meaningful information. You might also want to use this information to trigger behavioural change or feed these added value insights into current policies and decision-making.

How can this be done?

Turning data and information into knowledge and insights requires analysis of the data. It goes beyond data visualisation and interpretation (more about that here), since it implies performing more complex operations and using the collected data.

This step needs to be informed by scientific expertise, depending on which environmental issue you are focusing on, to make the analysis reliable. For this reason, it is important to make sure you don't tackle this process without the support of relevant scientists, who will guide the data analysis and propose suitable methodologies for generating relevant and trustworthy conclusions (more on how to engage key stakeholders here).

Data analysis can be done deductively or inductively. Deductive data analysis means answering the research question using existing scientific concepts, theories and methods. Inductive data analysis starts with data broadly related to a topic (not with research questions) and looks for patterns in the data to arrive at insights and explanations for those patterns.

Useful Resources

TOOLS: **Google Maps** and **Google Charts** are easy and inexpensive tools to help Citizen Observatories do some simple EDA.

TOOL: QGIS is a free and open-source Geographic Information System in which users can access various types of spatial analysis tools for working with their data.

BOOK: Python for data analysis is a useful open-source book on the Python programming language, which can be used to analyse data.

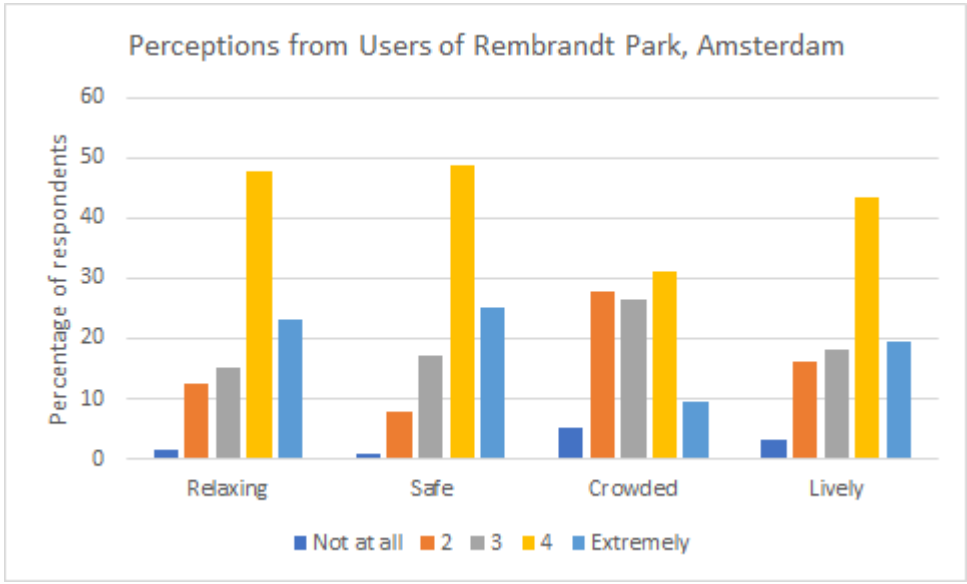
DATA ANALYSIS TOOL: Building on python for data processing, the use of **Pandas** is one of the most popular choices due to its simplicity and complete ecosystem.

– Research question-driven data analysis

This refers to data analysis that is driven by the research question that has been derived from the environmental issue that is at the heart of your Citizen Observatory (more on how to identify the issue here). The research question might be related to understanding the current situation of a particular phenomenon. Examples of such questions are: How polluted is my city, and where are the pollution hotspots? What species of butterfly are most prevalent in my area and why? How do citizens perceive the green spaces in my city, and how can I use this information to make improvements? An example from the LandSense project tackles this latter question. Statistical methods can be used to answer these types of questions, from simple summaries (as shown in the BOX below) used to understand the current situation, to the development of statistical models that can be used to explain the reasons for these findings.

Example from the LandSense project

As part of the LandSense project, the Mijn Park mobile app was developed and used to gather information about green spaces in Amsterdam. Regular users of Rembrandt Park were asked about their perceptions of the park in order to improve these spaces and to inform policy on future greenspace development. Participants were asked to answer questions in which they rated, on a scale of 1 (not at all) to 5 (extremely), information about how they thought this space could be better understood.



TOOL: The **R programming language** provides very powerful data analysis tools.

SCIENTIFIC PAPER: The paper **"Assess citizen science based land cover maps with remote sensing products: the Ground Truth 2.0 data quality tool"** provides information about a tool which shows and compares maps as part of the MiraMon Map Browser.

VIDEO: **"How We Did It: Analysing Data "** describes data analysis approaches from the different Citizen Observatories in the WeObserve project.

TOOL: The **MiraMon Map Browser** is a tool for creating visualisations and analysing data that is provided as open-source code.

TOOL: PYBOSSA is a crowdsourcing framework to analyse or enrich data that can't be processed by machines alone.

The graph above summarises some of the data collected. Although users generally found the park to be relaxing and safe, there were some issues with crowding. Other questions were asked regarding park facilities, such as how satisfied individuals were with the trees, the park benches, the waste facilities, etc., so that the local decision-making authority could understand which issues were the most important to regular users of the park and which could be easily addressed.

The research question may also be related to changes in a particular phenomenon over time. For example: Are some key species of plants flowering later than they have in the past? Have some species of butterfly or bird declined over the past few years?

Trend analysis, among others, can be used to look for statistically significant changes over time. There are many different statistical methods available, and the scientific expertise that is part of your Citizen Observatory can help with choosing and applying the most appropriate types of statistical analysis for your data set.

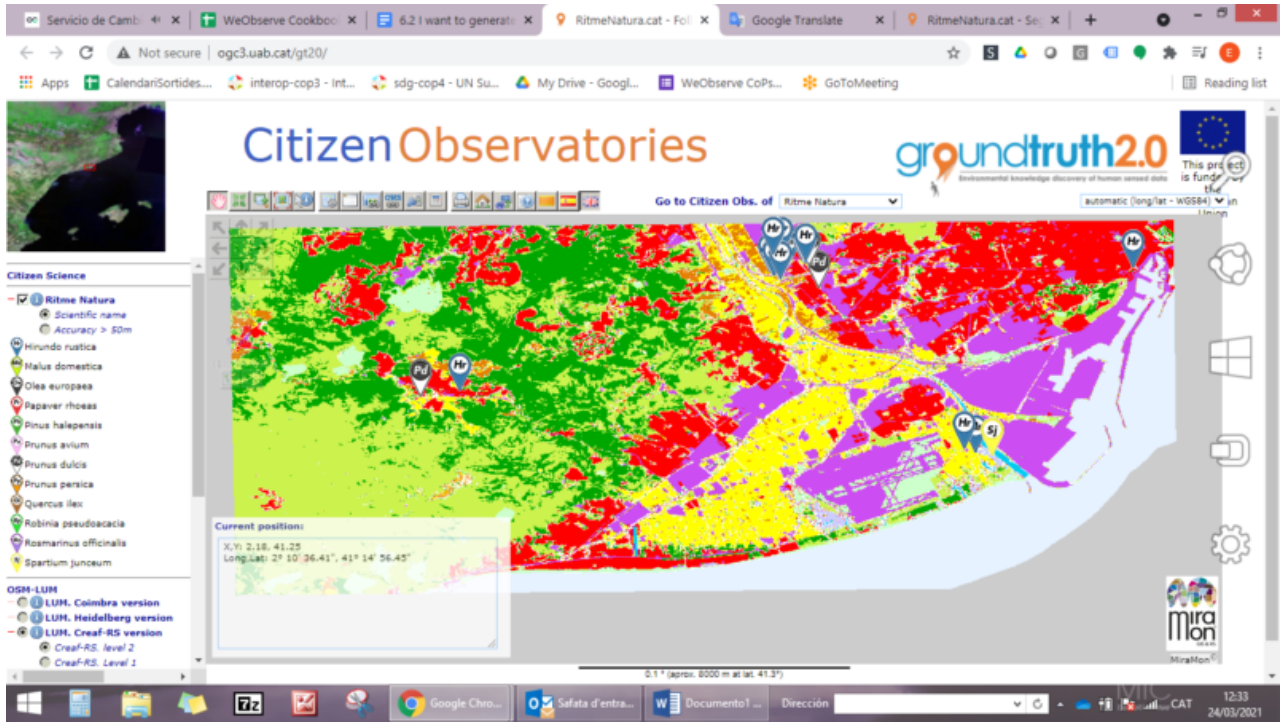
- Exploratory data analysis

Exploratory Data Analysis (EDA) refers to a set of tools for finding patterns in the data, developed originally by the Turkish government (1977). This can involve very simple operations such as summarising the data through statistics such as the minimum, maximum, median, quartiles, etc., which can then be visualised using box plots, scatter plots, etc. This can also help you to identify outliers in your data or observations that you were not expecting. In addition to testing existing hypotheses that you might have, it can also provide new hypotheses, which can then be further tested.

This video provides an example that you might find useful. EDA can also be expanded to look for patterns in geographical space or over time, called Exploratory Spatial Data Analysis (ESDA). Here is a video that discusses both EDA and ESDA. There are many different techniques available for doing these types of analyses. For example, global and local spatial statistics can show areas of ‘hot’ or ‘cool’ spots in your data.

Example from the Ground Truth 2.0 project

The data visualisation tool developed by the Ground Truth 2.0 project, provides the observations of the RitmeNatura Citizen Observatory and shows seasonal changes of species over a land use map of the zone; this indicates the kind of environment or vegetation that we can find there. This information can help users to find trends in the data collected and can give wider information than single observations can. These same observations could be combined with data on temperatures, which can help to explain the progress of the seasonal variations in the observed tree in that zone. Together, this information could be used to build a model to forecast tree species in different biomes.



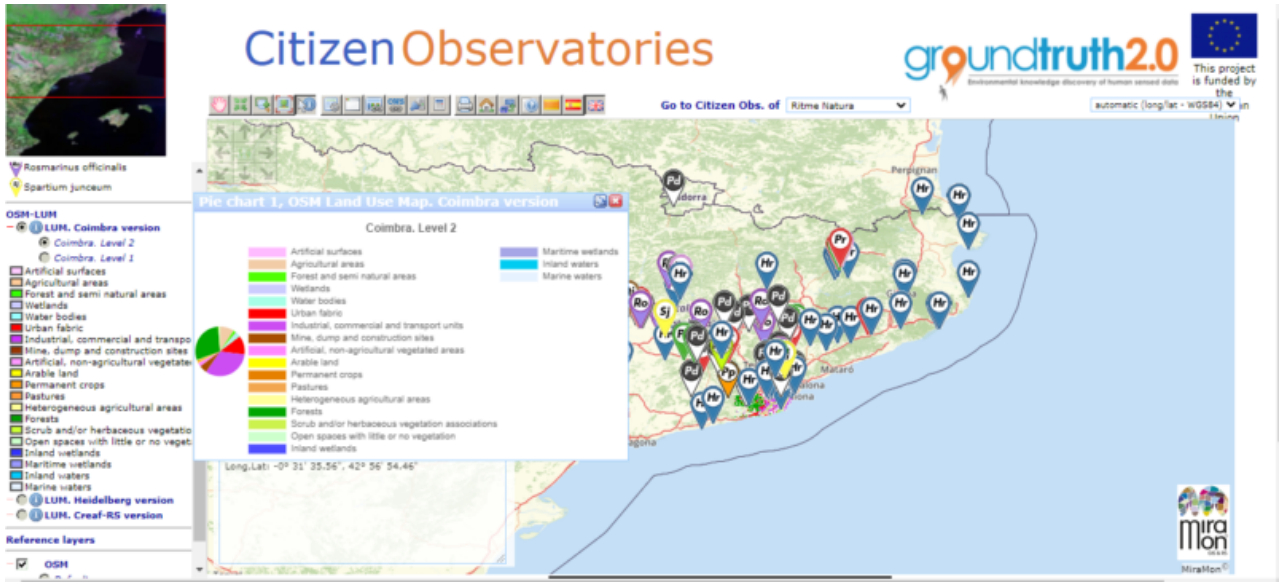
– Tools for data analysis

Although there are tools for off-the-shelf data analysis such as QGIS (see list of useful resources), you might want to use more advanced data processing tools. Examples are the Python programming language, which is relatively easy to learn, and associated libraries such as Pandas, which has built-in data processing functions.

The R programming language and statistical environment also provides open source tools for powerful data analysis.

Example from the Ground Truth 2.0 project

For data analysis in the Ground Truth 2.0 project, a tool was integrated in the Citizen Observatories data web browser that provides further analytical functions such as querying the data, e.g. filtering the observations by different attributes, computing the quality of the observations, summarising the data using pie charts, reclassifying the values in the layers to new categories, and combining different raster layers to produce added value information.



You may also be interested in:

I want to generate insights & results from our data & knowledge...

...by understanding & interpreting the data

I want to achieve impact with Citizen Observatory results

by communicating the Citizen Observatory results effectively

Why is it relevant?

Good communication is important for any project, but it is particularly crucial for Citizen Observatories. They rely on sustained public involvement in order to gather relevant data, but also because they often aim to bring about change – be that policy change, environmental governance change, or even behavioural change. Communicating interim results helps to keep motivation and engagement high among participants. Effectively communicating the outcomes to the right decision-makers is key to bringing about those desired changes.

How can this be done?

In many ways, good communication practices are quite universal. It is important to identify your target audience, use language and visualisations that are relevant and clear, and select the most fitting communication channels and mediums for both the message and the audience. It is also important that you plan for good communication before the launch of a Citizen Observatory initiative in order to ensure that the necessary resources are in place, such as a person or people that are responsible for these activities, and the budget to develop the materials and channels that they will need. This planning should include an understanding of the target audiences, their motivations for taking part, the messaging, and what actions you are asking them to take.

Useful Resources

BOOK CHAPTER: The chapter "**Communication and Dissemination in Citizen Science**" in the book "**The Science of Citizen Science**" describes the importance of communication and dissemination in citizen science more generally. It provides examples of successful strategies and identifies the factors that determine success. It also describes some of the challenges that can arise and how to overcome these.

PAPER: The paper "**Citizen Scientists' Preferences for Communication of Scientific Output: A Literature Review**" contains the outcomes of a review on participants' preferences for communication of data, findings, and scientific publications in the context of citizen science projects, which will also be relevant for Citizen Observatories.

– Good communication practices

Good communication practices in the wider field of citizen science emphasise the participatory nature of citizen science, such that communication should always be flowing between all who are involved (i.e., two-way or multi-directional communication). Participants should be kept informed of progress frequently but should also be able to communicate with project leaders to make their own contributions and suggestions.

Recommendations for communication in citizen science (from Innovation in Citizen Science – Perspectives on Science-Policy Advances)

GUIDELINES: This practical guide to communication and engagement in citizen science, "**Communication in Citizen Science**" provides valuable guidance for developing and executing a communication plan for a citizen science initiative or Citizen Observatory.

SCIENTIFIC PAPER: The WeObserve Impact CoP has developed **a storytelling approach to capturing and communicating impact**. To illustrate how this works, it has been applied to four case studies.

– Specific communication practices for Citizen Observatories

In the specific case of a Citizen Observatory, you will want to spend some time thinking about what types of impact you are aiming for; what information, data and results will be needed to achieve those impacts; and therefore what types of communication will be most appropriate. For example, is your aim to provide policy-makers with data that will inform the development of new policies or regulations? If so, you will want to spend some time working with them to understand their information needs: what format should that data be presented in, is there a specific moment in time that they will need to receive this data, and how will they use that data further to bring about the desired impacts? By finding out these needs in advance, you will be able to plan for them from the beginning.

Consider these methodologies from the beginning of the observatory and try to plan what type of dissemination you will use with the citizen community. Plan also to dedicate some resources to this type of activities and to the elaboration of adequate contents. Putting in place mechanisms to collect citizens feedback will help in better focusing and addressing future dissemination activities.

You may also be interested in:

I want to achieve impact with the Citizen Observatory results...

...by triggering change

...by linking the Citizen Observatory to the SDGs

...by adopting open data policies & data standards

Examples from the Mapping for Change project to measure noise pollution in London's Pepys Estate

People living in the Pepys Estate in London, England were suffering from noise pollution from a scrapyard near the centre of the estate and very close to both a primary and nursery school, but after more than six years of trying to deal with this problem and raising concerns with the Mayor of Lewisham and others, the disturbance started to escalate.

With the support of the "Mapping Change for Sustainable Communities" project run by the London 21 sustainability network and a research group within the University College London (which later spun out into the Social Enterprise Mapping for Change), members of the community used noise meters to make over 1500 measurements at all times of day and night and developed their own 'noise maps'. Armed with this information, the community initiative called a public meeting to present their findings to the Council and the Environment Agency.

Recognising from the robust data that there was a real and tangible problem, Lewisham Council and the Environment Agency appointed an acoustic consultant to carry out a detailed analysis of noise in and from the scrapyard. This resulted in the license of the scrapyard being revoked.

- *A description of the impact of this noise mapping approach and other community mapping initiatives of Mapping for Change can be found here.*

- *The Citizen Observatory initiative described above was followed up with an investigation of local air quality by the same community of residents. The 'data stories' gathered in that initiative as part of the Urban Sensing Citizen Observatory, and other stories from parallel initiatives, are described in this report on the Citizen Sense website.*

The concept of 'just good enough' data for decision-making purposes is explored further in this paper by Jennifer Gabrys and Helen Pritchard: "Just Good Enough Data and Environmental Sensing: Moving Beyond Regulatory Benchmarks toward Citizen Action".

Example from the Citizen Observatory of Water for flood risk management in the Brenta-Bacchiglione catchment, Italy

The Citizen Observatory of Water implemented in the Brenta-Bacchiglione catchment started as a pilot for the WeSenseIt project, with the aim to increase the resilience of the local communities during floods.

Since having demonstrated its value in addressing residual flood risk, it has been promoted via local and national media at the national and European levels as an example of awareness-raising and active public involvement in water management policy, strengthening communication channels before and during flood events.

This resulted in the inclusion in the non-structural mitigation measures of the Flood Risk Management Plan of the Eastern Alps Hydrographic District and in the financing of the measure by the Italian Ministry of Environment.

An important part of the success of the initiative is the communication plan, which will continue over the next five years.

In addition to communication through the Citizen Observatory website and via social media campaigns, radio broadcasts and regional newspapers, the plan also includes the development of educational programmes for teachers and students within the 120 municipalities currently located in high-flood-risk zones in the Brenta-Bachiglione catchment area.

The education campaigns help to increase student awareness of existing flood risks in their own area and to help them recognise the value of the Citizen Observatory in protecting their families. Through this they learn that by providing important information about flooding, they can contribute to everyone's safety.

Example from the WeObserve project

Knowledge collected from Citizen Observatories, the WeObserve Communities of Practice and the other related initiatives has been consolidated in the WeObserve project in two policy briefs with recommendations for policy-makers on how to foster Citizen Observatories to address environmental challenges. The first policy brief, entitled "A Roadmap for Citizen Science in GEO – The essence of the Lisbon Declaration", aims to secure the integration of Citizen Science and Citizen Observatories into the Global Earth Observation System of Systems (GEOSS).

This policy brief summarises three key messages from the Lisbon Declaration for European policy-makers and describes how best to connect and integrate Citizen Science communities as well as their activities and outputs into GEO. The second policy brief, entitled "Mission Sustainable: Fostering an enabling environment for sustainable Citizen Observatories", provides recommendations that can contribute to the generation, execution and sustainability of Citizen Observatories. Based on a range of inputs from practitioners, the policy brief makes four specific recommendations to European and national funding bodies and policy-makers for fostering an enabling environment that can contribute to the generation, execution and sustainability of Citizen Observatories, thereby maximising their impact.

I want to achieve impact with the Citizen Observatory results

by triggering change

Why is it relevant?

Citizen Observatories can trigger various changes. Most typically, Citizen Observatories aim to help make improvements in the physical environment. However, impacts can also range from changes in public awareness and understanding to changes in individual people's behaviour or changes in policy. Although many Citizen Observatories aim for one or more of these changes, each type of change requires deliberate actions to be attainable.

How can this be done?

There are different ways that Citizen Observatories can improve the environment and trigger social and institutional changes: they can help raise awareness among the wider public about the specific environmental issues; they can help foster behavioural changes in individuals, groups and entire communities related to the causes of the environmental concern at the heart of the Citizen Observatory; and they can contribute to policy changes.

There is no single formula for achieving these impacts. Rather, it is important to think about the type of change you envisage, what has to change in the present and the steps you can take towards long-term impact and change. Often this is done at the start of setting up the Citizen Observatory, especially if it is being co-designed (more on co-designing a Citizen Observatory here). Moreover, while it is possible to trigger some specific changes, it is also important to realise that many changes are actually beyond the immediate control of your Citizen Observatory. Finally, when the members of your Citizen Observatory co-create the change they want to see, solutions are more democratic and include a wider variety of perspectives.

SCIENTIFIC PAPER: The WeObserve Impact CoP has developed **a storytelling approach to capturing and communicating impact**. To illustrate how this works, it has been applied to four case studies.

TOOL: The **Future Newspaper Tool** is an open-source downloadable tool that has been developed with community-led citizen science projects in mind. The tool can be used after the monitoring activities and helps the creative reflection process by asking participants to imagine a variety of desirable futures.

– Awareness raising

Not everybody is acutely aware of the environmental issue that your Citizen Observatory is focused on, and they may not realise what the longer-term implications are of continuing with 'business as usual'. Using your Citizen Observatory's results to raise awareness among the public can generate interest in, and understanding about, the environmental issue at hand and create the foundation for substantial and prolonged changes (see sections 'Behavioural change' and 'Policy change' below).

There are various ways to raise awareness among the wider public that can be applied by Citizen Observatories. These include informing the media and holding public events to share, disseminate and discuss the results of your monitoring activities and how they relate to the specific environmental issues your Citizen Observatory is focused on, as well as the general communication activities presented here.

Participants of the Making Sense project in Barcelona use the Future Newspaper Tool to decide on which actions they would like to take. © Making Sense

PROJECT REPORT: The Making Sense **Report on toolkit resources, methods for actionability and evaluation of findings from data** gives an overview of the project and the methods that were used by the communities, including those for the planning and delivery of action and change making.

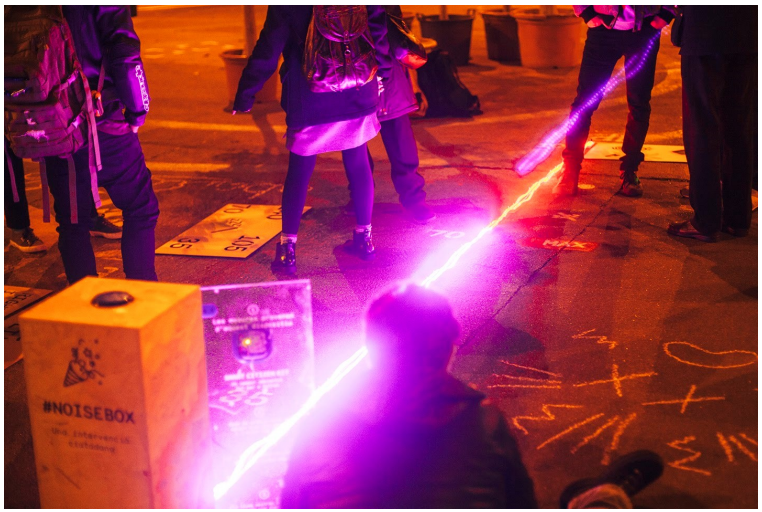
LEARNING RESOURCE: The online course **Citizen Science Projects: How to make a difference** on FutureLearn has additional information on how to achieve impact by triggering change.

PROJECT REPORT: **Engagement activities and their impacts on policy development** includes FAO slides from one of the GROW MOOCs covering multi-stakeholder soil governance models.

Example from the Making Sense project

During the Making Sense project, a group of community champions wanted to find out about noise pollution in Barcelona, their home city. After they discovered that they were regularly being exposed to unhealthy levels of noise, they wanted to create a public action that illustrated the problem of noise levels in the city. Using the Future Newspaper tool they imagined a world in which their data was already actionable. They envisioned an event where people could visually see the noise levels in their community. This became the Noise Box, an interactive public intervention that hooked a sensor up to an LED strip which would light up and turn from green to red when the ambient noise picked up by the sensor went over the World Health Organisation's recommendation of exposure.

They brought the Noise Box to the streets of Barcelona and used it as a way to engage with lots of people on the issue of noise pollution. This is a great creative way to use the sensors and data to communicate with others about the problem!



Participants of the Making Sense project in Barcelona take their interactive Noise Box to the streets of the city to communicate issues around noise pollution. © Making Sense

You may also be interested in:

I want to achieve impact with the Citizen Observatory results...

...by triggering change

...by communicating the Citizen Observatory results effectively

...by linking the Citizen Observatory to the SDGs

...by adopting open data policies & data standards

Lessons learned from the Landsense project

One of the aims of the LandSense project was to work with stakeholders such as local authorities, farmers and indigenous communities to raise awareness about digital technologies and new sources of data from Earth Observation. Working with the City of Amsterdam's planning department was challenging, because it had limited budgets and was used to more conventional methods of data collection, i.e., surveys. Together with the planning department, LandSense developed the MijnPark app to gather information about citizens' perceptions of greenspace, focussing initially on Rembrandt Park. The city of Amsterdam saw the value of this type of data and is now continuing to work with one of LandSense's partners (the Free University of Amsterdam) to gather more data from citizens. Another example is working with farmers in Serbia, who were not used to using digital technologies as part of their farming practices and were also reluctant due to being very busy. By helping them to digitise their fields with information using the CropSupport app developed in the project, we showed them how they can obtain Earth Observation data in return, e.g. on crop health. Finally, working with indigenous communities in Indonesia, threats were reported using the NaturaAlert mobile app developed during the project, which was fed by alerts of new threats from the Earth Observation-driven change detection service. Although many had mobile phones, such an application was entirely new to them. As part of LandSense, we successfully bridged some digital divides while raising awareness on how the use of digital technologies and Earth Observation can benefit the communities.

- Behavioural change

Using your Citizen Observatory and its results to achieve changes in the behaviours of individuals, groups or entire communities is a very ambitious impact to achieve, but not impossible. In some Citizen Observatories, the volunteers' own behaviour becomes more sustainable as a result of their monitoring activities.

For example, citizen participation in the Ground Truth 2.0 Citizen Observatory Meet Mee Mechelen, air quality monitoring activities, discussions with other Citizen Observatory stakeholders and the overall results have caused some participants to reduce their car usage.

Especially for very short distances, they now walk, cycle, use public transport or ‘cleaner’ cars. Of course, not all members of the public will participate in your Citizen Observatory, so it’s important to reach the ‘non-participants’ and engage them with your results. Dedicated public events, especially those held in workshop style, can be a good way to share your results, spark discussion and help trigger new habits. These can be supported, for example, through community-driven social media challenges.

GROW example of change in water usage of growers

The GROW Observatory focused on soil monitoring and regenerative food growing places. GROW engaged 24 communities in 13 European countries to create an unprecedented network of 6,502 ground-based soil sensors and a dataset of 516M rows of soil data. One of the GROW Places was in El Hierro (one of the Canary Islands). The local government allowed access to public land for installing sensors; thanks to this involvement, sensors covered all the different climates of the island. In addition, because the resulting GROW soil moisture data were directly meaningful to the participants’ growing practices, they were able to interpret sensor data and take action.

For example, just a month after citizen scientists in El Hierro began their sensing activities, some farmers realised that they were over-irrigating their banana crops, and as a result they reduced the use of water for irrigation by about 30% right away.

Banana farmers in Las Canarias part of GROW Place Spain

“On our farm, we reduced water use by 30% just after a [sic] month of data collection. We found that the plants are happy enough with 40 min irrigation instead of 1 hour.” (Michal Mos, El Hierro Community Champion)

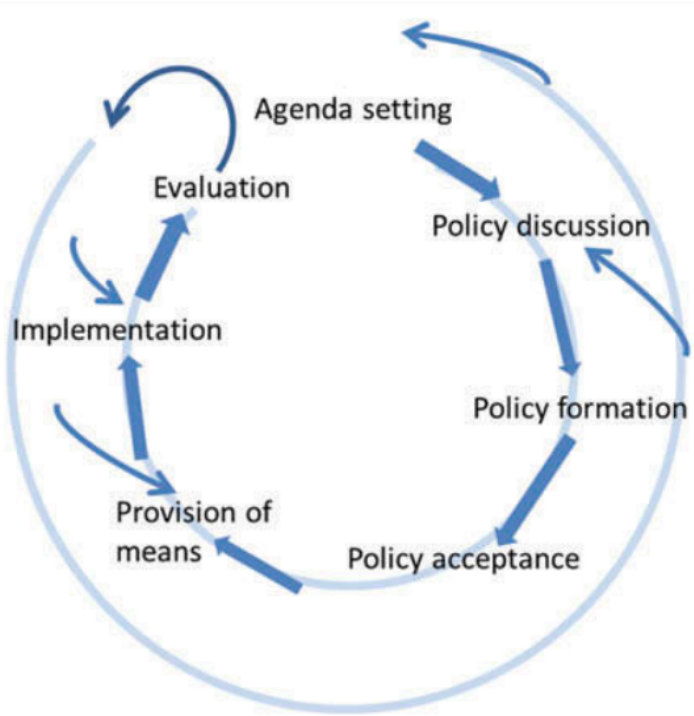
– Policy change

In the context of Citizen Observatories, there is an inherent intent to create policy impact, promoting a blueprint for making both science and policy with people, rather than only for people (more on the characteristics of Citizen Observatories here). In principle, Citizen Observatories can play an important role in supporting evidence-based policy-making, and thus democratising the policy-making process as well as the knowledge creation process. This stems from the deliberate focus of Citizen Observatories on public decision-making and policy change, ideally facilitated via the involvement of decision-makers from public authorities who are in charge of implementing policy, and/or policy-makers who set policy. In practice, achieving this kind of impact requires deliberate attention and effort.

Changing policy implies understanding how the so-called 'policy-making cycle' works, as this has its own dynamic. Moreover, you need to identify the policy domain(s) that are linked to the environmental issue that your Citizen Observatory focuses on. For example, your issue may cut across one or more of the following: urban and rural planning, flood risk management, biodiversity conservation, natural resources management, and climate adaptation and mitigation.

It's good practice to involve decision-makers from public authorities who are in charge of implementing the concerned policy, or at least to inform relevant policy-makers during the set-up of your Citizen Observatory (more on how to engage key stakeholders here and here).

As your Citizen Observatory evolves, liaising regularly with policy-makers from the relevant policy domains can ensure that you remain up to date on developments in their respective policy cycle,



Policy cycle (Höchtl, Parycek & Schöllhammer, 2015)

e.g. such as upcoming public consultations on spatial planning in your city or region. This enables you to understand what evidence is required for making or changing policy and to feed relevant data, information and insights into the process.

– Transforming results into actionable recommendations

Triggering change in policy adoption can be facilitated through an effective dissemination of the citizen science research results. But reaching the policy community can be challenging. Targeted results should be disseminated to decision-makers to facilitate the uptake of results. Sharing results with policy-makers can ensure that your research is applied and that it can lead to behavioural or collective change. In summary, it can ensure that your research has an impact. Inherent to a Citizen Observatory is to involve policy-makers from the beginning and to also keep them informed during the development of the project. You should incorporate their perspectives in order not to advance in separate ways.

When promoting your results with policy-makers, use dedicated events with dialogue and debate, and prepare clear and succinct policy briefs in which they can find the key impacts and implications of your project for their decision-making processes. The WeObserve project, aiming at moving citizen science into the mainstream, has developed two policy briefs and has organised and participated in several dedicated events where citizen science has been promoted in political agendas, in particular with regard to the UN Sustainable Development Goals.

Lessons learned from the Ground Truth 2.0 project

One of the Ground Truth 2.0 Citizen Observatories, RitmeNatura, is dedicated to the observation of phenological changes in plants and animals due to seasonal evolution, such as the flowering of plants, the emergence or falling of leaves, or the migrations of birds. This observation needs to be carried out by an extensive network of volunteers in order to provide valid data that can be compared with the corresponding climatic series, in terms of geographical coverage, species coverage and temporal coverage.

In the co-design process during which the observatory was created, following the guidance of the Ground Truth 2.0 methodology, citizens, scientists and decision-makers were brought together to share their needs and expectations in relation to the Citizen Observatory.

Emerging from this process, a collaboration agreement was signed between two of the stakeholders, the Barcelona Provincial Council, in charge of the management of the Natural Parks network, and the Catalan Meteorological Service, in charge of the Phenological network of Catalonia. In the agreement, the park rangers who depend on the Provincial Council would serve in the Phenological Network as observers, incorporating their phenological observations in the park into their daily activities as rangers.

In this case, the Citizen Observatory was the triggering force that facilitated the contact between the organisations and raised awareness among them about the importance of the phenological observation and the possibilities existing for the two institutions.

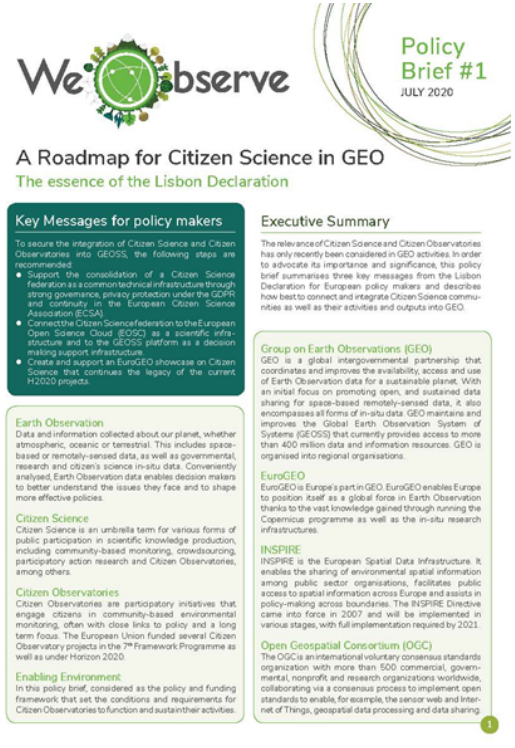
Example from the Brenta-Bacchiglione Citizen Observatory

As part of the Flood Risk Management Plan (FRMP) of the Brenta-Bacchiglione catchment, a Citizen Observatory for flood risk management was set up during the WeSenseIt project (FP7, 2012-2016). Citizens were involved through monitoring water levels and providing other relevant information through mobile apps, linking Citizen Observatories with hydrological modelling to raise awareness of flood hazards and to facilitate two-way communication between citizens and local authorities. A Cost–Benefit Analysis (CBA) of this Citizen Observatory was done to demonstrate the value of this approach in monetary terms to ensure the wider acceptance of Citizen Observatories by policy-makers in Italy. The CBA demonstrated that a Citizen Observatory can decrease the social vulnerability of flood risk and reduce the average annual avoided damage costs by 45% compared to a 'business as usual' scenario (Ferri et al., 2020). The evidence of the social and economic value generated by the Citizen Observatory made it possible not only to raise funds from the Italian Ministry of Environment for the continued implementation of the Citizen Observatory;

it also served to embed Citizen Observatories as a non-structural flood risk mitigation measure (M43 measure) in regional flood management policies.

Example from the WeObserve project

The WeObserve project has collected knowledge from Citizen Observatories, the WeObserve Communities of Practice, and other related initiatives and has consolidated these in two policy briefs with recommendations for policy-makers on how to foster Citizen Observatories to address environmental challenges. The first policy brief, entitled 'A Roadmap for Citizen Science in GEO – The essence of the Lisbon Declaration', aims to secure the integration of Citizen Science and Citizen Observatories into Global Earth Observation System of Systems (GEOSS). This policy brief summarises three key messages from the Lisbon Declaration for European policy-makers and describes how best to connect and integrate Citizen Science communities as well as their activities and outputs into GEO. The second policy brief, entitled 'Mission Sustainable: Fostering an enabling environment for sustainable Citizen Observatories', provides recommendations that can contribute to the generation, execution and sustainability of Citizen Observatories.



Based on a range of inputs from practitioners, the policy brief makes four specific recommendations to European and national funding bodies and policy-makers for fostering an enabling environment that can contribute to the generation, execution and sustainability of Citizen Observatories, thereby maximising their impact.

I want to achieve impact with the citizen observatory results

by linking the citizen observatory to the SDGs

Why is it relevant?

Achieving the UN Sustainable Development Goals (SDGs) requires accurate, timely and comprehensive data in order to make informed decisions and improve people's lives. However, there are major gaps in the data and knowledge that feed into policy and practice for achieving the SDGs and impact. Fortunately, there are many Citizen Observatories and citizen science initiatives that could match these data needs. It is therefore important that your Citizen Observatory become aware of the SDG data needs and how you can contribute to these goals.

How can this be addressed?

To address these data gaps and needs, we need to unlock the potential of Citizen Observatory and citizen science data, and integrate them into the official statistics for SDG monitoring. Citizen science and Citizen Observatories can complement traditional sources of data, enable active citizen involvement in the SDG processes and ensure government accountability. Therefore, they have strong potential to leverage the SDGs as an active agent and monitor of change.

Useful Resources

▶ **VIDEO**: **Social/policy impact of citizen science & observatories** shows how citizen science can help to fill data gaps, inform policies, increase awareness and promote behavioural change.

SCIENTIFIC PAPER: **"Mapping citizen science contributions to the UN Sustainable Development Goals"** presents an overview of where citizen science is already contributing and could contribute data to the SDG indicator framework.

As Citizen Observatory project leaders and community managers, you can do the following things to realise the full potential of Citizen Observatories and citizen science for SDG monitoring:

- Clearly **indicate and promote** which SDG indicator(s) your Citizen Observatory aims to contribute to (e.g. on your website, apps, social media accounts);
- **Communicate** which data quality assurance procedures you are using to comply with the quality standards and requirements of the National Statistical Offices (NSOs) and other government and UN agencies;
- **Support** open data for your Citizen Observatories that are formatted using standards, e.g., a new data and metadata standard for Public Participation in Scientific Research (PPSR);
- **Approach** the NSOs and other relevant national and international organisations if you are just designing your Citizen Observatory (find out more here and here);
- **Develop** your use case(s) and demonstrate successful results, e.g., where your data have been used in innovative ways, particularly by NSOs and/or UN agencies;
- **Build awareness and share experiences** with other initiatives on the use of their Citizen Observatory for the SDGs;
- **Make the case** for integrating citizen science and Citizen Observatory data into the methodologies of SDG indicators;
- **Promote** consistent data collection across Citizen Observatory and citizen science initiatives;
- **Sustain** your Citizen Observatory through innovative funding schemes to ensure continued contribution to the SDGs; and
- **Join** like-minded practitioners and groups to share experiences and learn from each other, such as through the WeObserve SDGs and Citizen Observatories Community of Practice (SDGs CoP).

SCIENTIFIC PAPER: **"Citizen science and the United Nations Sustainable Development Goals"** presents a roadmap that outlines how citizen science can be integrated into the formal Sustainable Development Goals reporting mechanisms as an emerging example of a non-traditional data source that is already making a contribution to measure SDGs.

SCIENTIFIC PAPER: **"The role of combining national official statistics with global monitoring to close the data gaps in the environmental SDGs"** summarises how the environmental dimensions of the SDGS are being measured.

SCIENTIFIC PAPER: "**Local Action with Global Impact: The Case of the GROW Observatory and the Sustainable Development Goals**" reports on Citizen Observatories' potential to contribute to the Sustainable Development Goals, reflecting on the experience of the GROW Observatory.

Storymap on the contributions of citizen science data to SDG Monitoring

According to a systematic review undertaken by the WeObserve SDGs CoP, citizen science and Citizen Observatory data are already contributing and could potentially contribute to 33% of the SDG indicators. Their greatest contributions to the SDG framework would be to SDG 15 Life on Land, SDG 11 Sustainable Cities and Communities, SDG 3 Good Health and Wellbeing, and SDG 6 Clean Water and Sanitation. This also demonstrates that citizen science and Citizen Observatory data have the greatest potential for input to the environmental SDG indicators, 68% of which lack data according to UNEP.

CONFERENCE PAPER: "**Citizen Science Data Integration for Understanding Marine Litter**" analyses how citizen science and complementary activities not only provide a cost-effective mechanism for collecting data, but also provide an opportunity to increase awareness and action on issues relating to marine litter.

PROJECT REPORT: The WeObserve report "**D4.6 WO Monitoring of SDGs by COs. Recommendations and priorities**" includes an overview of the contributions of Citizen Observatories and citizen science to SDG monitoring. This is done through a mapping of current and recent Citizen Observatory / citizen science activities onto SDG indicators and targets to identify where and how they can support SDG monitoring and implementation efforts. The report also provides recommendations and priorities regarding how to bring Citizen Observatory and citizen science data into official statistics for SDG monitoring.

Example by the Picture Pile initiative

A good example of a potential contribution of citizen science and Citizen Observatories to SDG monitoring is the Picture Pile initiative. Picture Pile is a generic and flexible tool for ingesting imagery that can be rapidly classified by volunteers, such as very high-resolution satellite images or geotagged photographs. Picture Pile combines Earth Observation and citizen science and Citizen Observatory approaches that could be used for monitoring various SDG indicators, such as 1.5.2 Direct economic loss attributed to disasters in relation to global gross domestic product (GDP), 11.3.1 Ratio of land consumption rate to population growth rate and 14.1.1b Floating plastic debris density, among others.

For the uptake of the Picture Pile tool and data for SDG monitoring and reporting purposes, the project team has been working on demonstrating the value, methodology and results of Picture Pile to the data and statistics communities. To achieve that, they first identified the SDG indicators that could potentially be supported by Picture Pile and studied their methodologies. They then contacted the respective custodian agencies that are responsible for compiling and reporting SDG data at a global level to understand how the current Picture Pile methodology can be improved to match the data gaps and needs at the indicator level. This is still a work in progress. The team is well aware that such changes need time and effort to be applied in practice, as this requires not only technical adaptation and increased capacities, but also a mindshift. The team also plans to work with countries to enable the use of Picture Pile data at the national level to develop use cases and best practices that could set an example for other countries and NSOs.

You may also be interested in:

I want to achieve impact with the Citizen Observatory results...

...by communicating the Citizen Observatory results effectively

...by triggering change

...by adopting open data policies & data standards

Lessons learned from the Citizen Science for the SDGs (CS4SDGs) – Ghana project

Led by IIASA, the CS4SDGs – Ghana project (2020-2021) is a partnership between the UNSDSN, UNEP, Ghana Statistical Service (GSS), Ghana Environmental Protection Agency (EPA), Earth Challenge, Wilson Center, Ocean Conservancy, Smart Nature Freaks Youth Volunteer Foundation and others. The aim of the project is to act on the results of the WeObserve SDGs CoP paper, and use citizen science approaches for Ghana's official SDG monitoring/ reporting activities based on the country's policy priorities and data needs. As part of the project, the SDG indicator 14.1.1b on plastic debris density was identified to support Ghana for understanding the extent of the marine litter issue in the country using citizen science methodology and approaches. Some of learnings so far include:

- *Building key partnerships around citizen science and Citizen Observatory data is key to their successful uptake for SDG monitoring and impact;*
- *Instead of creating new initiatives from scratch, leveraging existing citizen science and Citizen Observatory initiatives serves to achieve more time- and resource-efficient results;*
- *By tapping into local networks, in this case "Smart Nature Freaks Youth Volunteers", data can be efficiently and sustainably collected as a by-product of existing activities; and*
- *Creating time and space for government, international organisations, CSOs, universities and others to meet is essential, in order to build trust, common goals and ownership over the results.*

I want to achieve impact with Citizen Observatory results

by adopting open data policies & data standards

Why is it relevant?

Applying open data policies to Citizen Observatories increases the impact of the data by preventing 'data silos' (storage of different data in different places) and thereby duplication of efforts. Adopting data standards lowers the technical barriers and opens new possibilities for exploiting the data by combining them with other themes and across locations.

How can this be achieved?

There are a range of tools and guidelines that can help your Citizen Observatory apply open data policies and data standards.

- Adopting open data policies

In the European Union, public sector organisations must comply with the Open Data and Public Sector Information Directive (ODPSI) that came into force in July 2019. This European Commission Directive focuses first on the economic aspects of the re-use of information and introduces the concept of high-value data sets. The second priority among the thematic categories of high-value data sets is Earth Observation and environment, which are the focus of many Citizen Observatories. The Aarhus Convention (by the United Nations Economic Commission for Europe) focuses on access to environmental information by citizens. These policies shape the context in which your Citizen Observatory has to function and with which it must comply.

Useful Resources

TOOL: **The Open Data Toolkit** is designed to help governments and open data enthusiasts understand the basic concepts of open data, how to plan and implement an open government data programme and some tricks on how to approach a dataset.

WEBSITE: The World Bank page on **Starting an Open Data Initiative** contains useful information and tools for those looking to take their first steps in an open data initiative.

CHECKLIST: The Open Data Institute page on **How to write a good open data policy** details the key steps to take in order to understand and develop strong open data practice.

The Global Earth Observation System of Systems (GEOSS) offers a single access point via its geoportal, connecting users to various environmental monitoring systems around the world while promoting the use of common technical standards to support their use. Similarly, the European Open Science Cloud (EOSC) provides a virtual environment with open and seamless services for the storage, management, analysis and re-use of research data.

Integrating available resources with mechanisms like GEOSS and EOSC, and leveraging their data management and FAIR principles, gives us a simple way to deal with open data obligations and to access research data across different disciplines while also promoting the use of open solutions and common standards for data sharing.

GEOSS was developed by the Group on Earth Observation (GEO). GEO's three Data Sharing Principles state that:

- there will be full and open exchange of data, metadata and products shared within GEOSS, recognising relevant international instruments and national policies and legislation;
- all shared data, metadata and products will be made available with a minimum time delay and at minimum cost; and
- all shared data, metadata and products are encouraged to be made available free of charge or at no more than reproduction cost for research and education.

The Open Data Institute (ODI) suggests that the general context for open data policy should first be developed, in order to define its scope. This should include:

- **a definition of open data** – why open data is important to the project and the reasons that a policy is needed;
- **general principles** to guide the release and reuse of open data;
- **the types of data collected** and whether they are covered by the policy; and
- **references to relevant legislation, policies or other guidance** that also apply to the management and sharing of information with third parties.

REPORT: **The Citizen Science Interoperability Experiment engineering report** focuses on the findings of the first phase of the WeObserve and OGC Citizen Science Interoperability Experiment

REPORT: The report **Recommendations on FAIR metrics for EOSC** proposes a set of metrics for FAIR data in EOSC to be extensively tested.

BOOK CHAPTER: "**A Conceptual Model for Participants and Activities in Citizen Science Projects**" in the book "The Science of Citizen Science" provides a conceptual model with which projects and data can be described in a standardised manner.

ODI has created a checklist of further policy elements to aid the development of open data policy:

- Data licensing and reuse rights
- Identifying and prioritising data for release
- Privacy considerations
- Data publishing standards
- Engaging with re-users
- Approach to consuming data
- Concrete commitments
- Policy transparency

ODI has also developed the Open Data Maturity Model, a tool for assessing the level at which an organisation utilises and shares open data. You can use this model, and also map your data practices, via the Open Data Pathway.

– Adopting data standards

A report by the Joint Research Centre of the European Commission from 2018 titled "An inventory of citizen science activities for environmental policies" identified 503 projects in the environment field, and Citizen Observatories are becoming more and more prevalent (more about the history of Citizen Observatories here). As the number of Citizen Observatories and citizen science projects increase, the need for standard practices has become even more critical. The Open Geospatial Consortium (OGC) and the WeObserve project are working on developing best practices on how to apply existing OGC standards for citizen science (see box below).

In parallel, several efforts have been undertaken by administrations and cartographic (mapping) agencies to set and use standard formats and services. This has resulted in the proliferation of Spatial Data Infrastructures (e.g. INSPIRE). The smart cities phenomenon is also possible thanks to the adoption of standard sensor and communication protocols.

POLICY: UNESCO is working towards building global consensus on open science via the development of a **UNESCO Recommendation on Open Science**, which includes Open Data policies.

CoP: The **Citizen Science & Open Science Community of Practice**, under the umbrella of the Citizen Science Global Partnership, is dedicated to stimulating exchange and cooperation between practitioners from the fields of citizen science and open science

PROJECT REPORT: **Engagement activities and their impacts on policy development** includes FAO slides from one of the GROW MOOCs covering multi-stakeholder soil governance models.

Citizen science initiatives each have their own characteristics (e.g. a myriad of data authors and a constant conversation and revision of the observations), but they also share many aspects, such as the geospatial nature of environmental measurements and the use of the same variables and observation types as other approaches (e.g 'smart cities' sensors).

Citizen Observatories can adopt and test current standards in their own domains. When they do not fit their purpose, they should be extended and adapted based on discussion towards finding consensus. The set of standards enabling sensor webs are a good starting point, as they focus on individual observations from a well-defined set of variables that are aggregated into data streams.

There is also a need for formal representation of Citizen Observatories as a whole as a key tool in enabling the discovery of data sets, projects and campaigns. It should facilitate knowledge sharing and contribute to current standardisation efforts. The Public Participation in Scientific Research (PPSR) Common Conceptual Model is a starting point in this direction.

You may also be interested in:

I want to achieve impact with the Citizen Observatory results...

...by communicating the Citizen Observatory results effectively

...by triggering change

...by linking the Citizen Observatory to the SDGs

Lessons learned from the Ground Truth 2.0 project and the Citizen Science Interoperability experiment.

During the Citizen Science Interoperability experiment, the following data servers providing support to the OGC Sensor Observation System (SOS) standard were deployed: MiraMon SOS server, Grow SOS, DLR istSOS SOS, and 52north SOS. Three clients were also produced: MiraMon SOS browser, Grow SOS data viewer, and 52north Helgoland. The group demonstrated interoperability by connecting the SOS clients to the SOS services and showing the data on clients, sometimes mixing data from different services and datasets in a single view.

The illustration presents air quality data from the HachAir project in the DLR premises, together with Ground Truth 2.0 data that uses the MiraMon SOS service.

I want to measure impacts of the citizen observatory **via a suitable approach**

Why is it relevant?

An evaluation of the impact and changes resulting from your Citizen Observatory is important for several reasons and can be done in different ways. For one thing, it will give you insight on whether your Citizen Observatory activities have been worthwhile to your community. But you will also want to capture this for the sake of others and help them learn about the potential of Citizen Observatories, so that they can follow in your footsteps. Finally, it also helps to demonstrate the value of Citizen Observatories to policy-makers, funders and others who may still be sceptical about Citizen Observatories in particular, and about citizen science in general.

How can this be done?

When you capture impacts, you make your Citizen Observatory visible, and you highlight the effects made by all of the participants involved in the activities. Different ways and tools for capturing the impacts of Citizen Observatories are quickly emerging, all useful for different purposes. You can use comprehensive impact assessment frameworks, for example, which have been developed and applied by researchers and scientists who study Citizen Observatories and citizen science. But these approaches can be complex and require a lot of experience, time and resources to apply. Some simplified versions are also available. Participatory evaluation methods (more about them here) provide the participants of a Citizen Observatory with an active role in the evaluation of their Citizen Observatory.

Thinking about how to measure the impacts of your citizen science initiative should not be the last – but rather one of the first things you do when planning your Citizen Observatory activities and resources.

Useful Resources

TOOL: WeObserve toolkit – Evaluation and advocacy. The tools in the 'Evaluation and Advocacy' category assist Citizens Observatories in considering how best to map and measure the impact of their activities.

CoP: The **WeObserve Impact Community of Practice** brings together practitioners of Citizen Observatories and citizen science to share and learn different ways of capturing impacts, including via participatory evaluation.

Tools that can be used at the beginning of your observatory to set goals and expected impacts are available here and here. They can be used throughout and at the end of the project to assess what's been achieved, remaining gaps and specific actions/areas for the observatory's next steps. These efforts and discussions can happen at several stages in the project, not just at the end. This will ensure you are measuring the right things and allocating the relevant resources to work in the direction of your desired impacts.
While trying to identify impacts too early in the process of setting up the observatory can be discouraging, as impacts might take some time to emerge, if it is done by carefully managing expectations, regular impact assessment discussions can help you adjust your activities in the right direction and maintain motivation and support for the Citizen Observatory.

You may also be interested in:

I want to measure impacts of the Citizen Observatory...

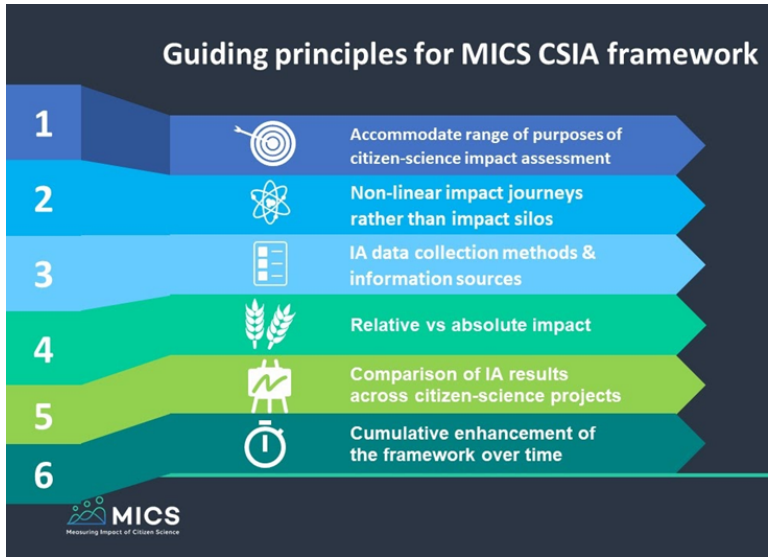
...via participatory evaluation

Example from the MICS project

Existing impact assessment approaches for Citizen Observatories and citizen science are dispersed, often too case-speci c, and focused on speci c domains of impact only. As a result, actual changes resulting from citizen science initiatives and Citizen Observatories are frequently either not noticed or are assumed, speculated about and incomparable with each other. Based on a systematic review of impact assessment approaches for citizen science and Citizen Observatories, the MICS project developed six recommendations for a comprehensive Citizen Science Assessment Framework. The resulting framework is intended to overcome the dispersion of approaches in assessing citizen science and Citizen Observatory impacts.

The CSIAF will be integrated in the MICS online platform, which will be an accessible means for Citizen Observatory leaders and community managers to be able to easily report and monitor the impacts of their Citizen Observatoryfrom the start and over time. The platform will also provide guidance on suitable methods for data collection to capture evidence of (emerging) impacts.

Moreover, citizen science practitioners, reviewers, policy-makers and other stakeholders will be able to better understand the impacts across Citizen Observatories and citizen science initiatives.



I want to measure impacts of the citizen observatory

via participatory evaluation

Why is it relevant?

Participatory evaluation provides Citizen Observatory participants with an active role in the evaluation of their Citizen Observatory. It helps to foster dialogue and encourages diverse stakeholder groups to consider different perspectives about the progress and impact of the Citizen Observatory.

How can this be done?

Participatory evaluation encourages Citizen Observatory participants to collectively capture and evaluate the impacts of the Citizen Observatory. In turn, they can reflect on the activities and understand what was successful and what needs improvement for future endeavours. It also allows them to further understand the value of collecting data and evidence about the environmental challenge which is pressing to them. The Co-Evaluation Tool, Community-Level Indicators, Insights Workshops and Impact Stories are some of the tools you can use for participatory evaluation of your Citizen Observatory.

- Co-Evaluation Tool

The Co-Evaluation Tool for citizen science can also be applied to Citizen Observatories. It aims at capturing how participation in a project has changed knowledge, practices and policy. This tool builds on the Place Standard Tool; it focuses on ten indicators of the different types of impact that could result from a project.

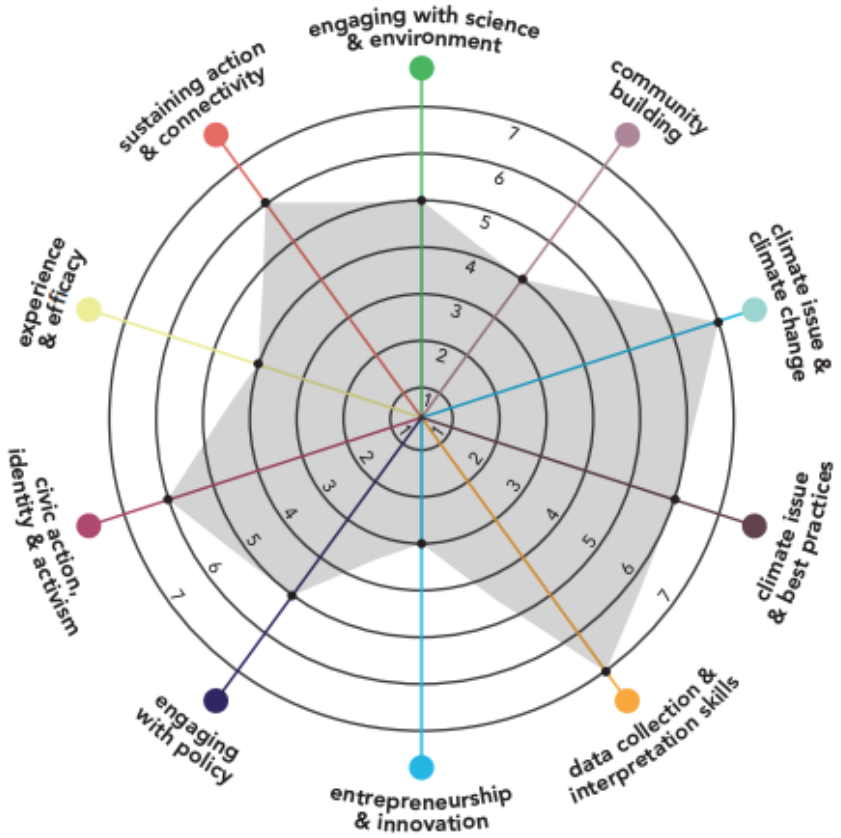
Useful Resources

TOOL: The **Co-Evaluation Tool** is open source and has been developed with community-led citizen science projects in mind.

TOOL: The **Community Level Indicators Tool** is open source and has been developed with community-led citizen science projects in mind. It is part of Citizen Sensing: A Toolkit, a collection of 25 methods and tools that can be used in citizen science projects.

SCIENTIFIC PAPER: **This paper** presents a qualitative study on the development of a novel approach to CLI during two projects that focused on noise pollution.

This tool, which encompasses a method and canvas, is designed for community members and citizen science practitioners wanting to evaluate a project. It provides prompting questions for discussions among participants, allowing communities and project managers to consider these indicators in a methodical way. This tool can be used at the end of a project to assess the impacts and changes achieved. It can also be useful at the beginning of a project as a way to collect an understanding among stakeholders.



Example of completed Co-Evaluation Tool ©GROW Observatory

CoP: The **WeObserve Impact Community of Practice** brings together practitioners of Citizen Observatories and citizen science to share and learn different ways of capturing impacts, including via participatory evaluation.

You may also be interested in:

I want to measure impacts of the Citizen Observatory...

...via a suitable approach

The Community Level Indicators (CLI) tool is designed for community members and citizen science practitioners wanting to start a new project and is designed to be used throughout a citizen science project. The CLI method involves asking community members to identify extra information that a community in a citizen science project can collect to complement and contextualise sensor data. For example, if a community is concerned about air pollution in their area, they might start a campaign to reduce the number of cars that drive on their street while using a sensor to monitor changes in air quality. The CLI, in this case, could be the measurement of car traffic on the street over the same period of time that the air quality is also measured and comparing the data to see if there is any correlation between the car traffic and the air quality. This toolkit helps participants to track the potential impact of their actions. The CLI tool helps participants to collaboratively choose what information will be collected, and how. This tool can also be used at the end of a data collection period, to see how actions have made a difference.

Participants of the Making Sense project in Barcelona complete the CLIs tool worksheet to decide which type of indicators they would like to collect ©Making Sense

- Insight Workshops

Insight workshops are a great way to reflect on the collaborative efforts of the participants and organisers, as well as engaging additional stakeholders who are not part of the core membership. The sessions can be formal or informal but should aim at iteratively presenting insights and results from the Observatory as they emerge rather than waiting for traditional publication, as well as conducting rolling evaluations on what went well and what could be improved. There are many different ways of conducting an insight workshop, but having a space where people feel comfortable to express their opinions is key.

A participant fills out a feedback questionnaire about the pilot during a final insight workshop during the Making Sense project in Barcelona. © Making Sense

Other helpful materials can be post-its for noting down pros and cons of the project, and sticker dots, which can be used for voting. Asking participants to fill out feedback questionnaires during these sessions is also a good way to have them reflect on the activities of the project.

- Impact stories

You can use impact stories to report on changes that result from your Citizen Observatory. An impact story is a narrative about your journey from when you started the Citizen Observatory. In your story, you will explain the issue you were trying to tackle and talk about moments or events when you were aware of a change that had occurred in relation to the problem you were working on. For example, you can use an impact story to report on a moment or event where you felt empowered in a discussion with authorities because you had gathered data and insights through your work as a citizen scientist.

The WeObserve Impact Community of Practice developed an approach that focuses on capturing and promoting policy impacts. The Impact Inquiry Instrument is available here.

Example from the Making Sense project

For Making Sense, participatory evaluation was crucial to the development of the project and also the participants' awareness of what they had learned about the environmental challenge. During a campaign in Barcelona, the participants got together for a workshop on CLI. They first agreed on a sensing strategy, which included where and when they would be collecting data on noise pollution using the Smart Citizen Kit.

They then used the CLI tool and worksheet to collectively decide on one or two other indicators that could be used for data annotation in combination with the sensor strategy. The workshop helped participants think about the problem differently. For example, some of the participants wanted to monitor the public presence in the area where the data on noise levels was being collected and then compare this information to the noise sensor data.

This allowed participants to overcome a culture of blame and to instead see the possibilities of collaborative decision-making. Also, the CLI workshop helped them make sense of the sensor data. By discussing the CLIs the participants were able to plan approaches that would build on the sensor's datasets to reveal deeper insights into the issue of noise pollution.

In one case, a participant used her phone to photograph the number of people on the street. These images evidenced the source of the problem. Once the community had gathered the sensor data, they used these photographs alongside the data sets to demonstrate the problem to local government officials.

I want to ensure sustainability of the Citizen Observatory after the funding period

by making outputs open access

Why is it relevant?

The incremental and regular release of outputs can help stakeholders develop a common understanding of the issue and solutions to it. In the long run, doing this may help stakeholders reorient the Citizen Observatory to new and emerging questions. For public authorities, such openness also facilitates the transparency, accountability and continuity of public participation.

How is this done?

Technology has changed the way knowledge and information is spread. When people invented printing and books, we had a tool for sharing knowledge that was costly to it in terms of writing and production, but this method could attribute the knowledge to its author. Now, moving forward into the increased use of online platforms and digital information, the outputs of Citizen Observatories can regularly be made open (publicly accessible) in the form of digested and impactful information that is useful and tailored for different stakeholders: citizens, scientists, and decision-makers.

- Publishing results as open access

As scientific work, citizen science results should be made available through and follow the open science recommendations for research visibility in science. These recommendations are based on the assumption that science results made freely available to the scientific and social communities will lead to a more collaborative, transparent and comprehensive advancement of collective knowledge.

Useful Resources

WEBSITE: The Open Knowledge Foundation lists **data licenses** which conform with the open definition

SCIENTIFIC PAPER: The paper "**The FAIR Guiding Principles for scientific data management and stewardship**" outlines the rationale behind the principles, and gives several examples of their use

WEBSITE: The **Frontiers website** offers detailed, peer-reviewed information and publications on citizen science methods

To this goal, any publication, such as research papers, proceedings, policy briefs, books and letters, describing your research results should be made openly available through their publication into open access journals, platforms and repositories. There are two ways to do this:

- **Gold Open Access**: This involves directly publishing your work in an online open access journal or repository. Open access platforms are those which guarantee that free access to research is made with no restrictions, both for the content and for the license agreements, entirely being open content licenses. This way the research results are made available for consultation, download, sharing and reuse immediately after their publication. Publication charges may apply to publications on open access platforms, as for other types of publications.
- **Green Open Access**: With this you can publish your work in a journal or repository with any kind of access policy and at the same time make available a copy of the work through an open access platform. In this case, the copy you wish to make open will need to be consistent with the legal restrictions imposed by the journal or repository in which the work is published. This can consist of an embargo period, the ability to publish only a pre-print version or some copyright restrictions. Of course, this way is less adequate for making the research results immediately and completely available to the research and social communities, as complete free access to research results is not given immediately.

Many sites and platforms offer open access storage and publication; you can find a list in the Directory of Open Access Journals (for journals and articles) or in the Registry of Open Access Repositories (which includes data repositories and open access journals and databases). The ones most often sed by the research community are probably Zenodo and OpenAIRE. In any case, when making your decision, it is essential to first check in detail the journal or site policy in relation to the copyright of the work in order to avoid further conflicts regarding the ownership and access rights to the content.

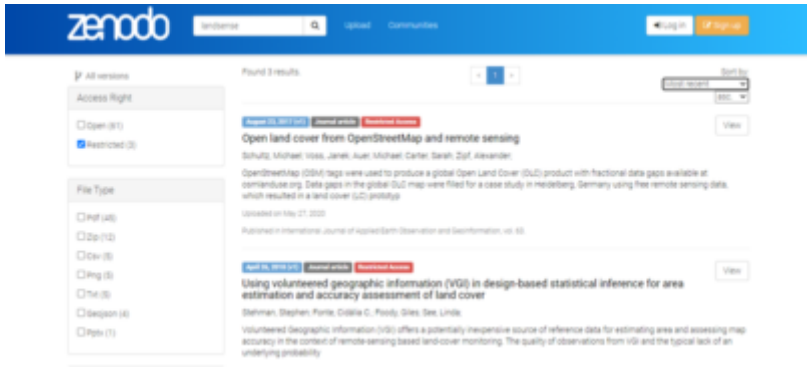
HANDBOOK: The **Open Science Training Handbook** provides a living handbook on open science training developed by the German National Library of Science and Technology. The focus of the handbook is how to spread ideas about open science most effectively.

GUIDELINES: The **OpenAIRE Guides for Researchers. How to select a data repository?** provides information and guidelines for selecting a data repository.

CATALOGUE: **Re3data.org** is a registry of research data repositories, containing useful information relating to open access data.

In recent times, there has been a general agreement that publication of results should be traceable back to the data that supports the conclusion. Since most Citizen Observatories are constantly adding new observations to their data sets, a frozen version of the data, conveniently anonymised and without any sensitive information in it, should also be made available through an open repository cited in the publication using a permanent and unique identifier (PID) for your data set. Examples of repositories that provide PIDs along with some basic metadata are GitHub, Zenodo, the Open Data Repository and the B2SHARE catalog. Many other thematic repositories exist, and you can find a catalogue on the re3data webpage. Make sure the repository you choose is adequate for the type and formats of your data and that it matches your needs in terms of licenses, as well as of costs of the service. Also, consider whether it will be useful for you to be notified about the use of your data.

Example from the LandSense project



The LandSense project has made its research results available in open access mode through the Zenodo repository, including research papers, posters, presentations and deliverables, as well as the related data sets, and including some publications which have restricted access due to the journal policy. In this case, at least the metadata of the work is provided so that everyone can know of the existence of the research and the work.

You may also be interested in:

I want to work with data...

...by sharing our Citizen Observatory data

I want to achieve impact with the Citizen Observatory results...

...by communicating the Citizen Observatory results effectively

...by adopting open data policies and standards

I want to ensure sustainability of the Citizen Observatory after the funding period...

...by accessing open funding calls

...by defining a new service

...by moving the infrastructure of the observatory into the cloud

...by collaborating with other Citizen Observatories with similar objectives

– Making results understandable for citizens

Ensuring the sound knowledge transfer of your Citizen Observatory results and their uptake by citizens (especially the participants of your Citizen Observatory) requires making the results easy to understand and clearly relating them to the problems you are trying to solve. This will help citizens to fully grasp the scope and meaning of the findings. Sharing and making the Citizen Observatory results open to citizens is particularly important for making sure the citizen scientists can receive and enjoy the fruits of their labour. Since coming to understand an issue is a process, it is also important to digest and disclose the Citizen Observatory outputs periodically with citizens and in this way ensure their continued support and participation, which is essential for the longer term sustainability of the Citizen Observatory.

When transferring knowledge to citizens, you can think of several channels and use them according to your type of Citizen Observatory. You can use online tools, face-to-face events, and/or printed materials or media dissemination.

Locally-based Citizen Observatories are better suited for face-to-face meetings or presentations, while global Citizen Observatories run better through online communication. Many times, the Citizen Observatory website can be the most important platform on which to share results with citizens, in particular if they already use it for participating in the project. Face-to-face presentations can provide a more direct and collaborative atmosphere and allow for a bidirectional knowledge exchange. Printed material summarising the project results in a clear language can be distributed. Other techniques can help with online dissemination: sharing outreach videos and reports, posting summary messages in the digital tools and apps and in the social media channels of the project, or distributing periodical newsletters in which project results can be synthesised. Media appearance is also a good way of disseminating your results, not only to the Citizen Observatory participants, but also to the larger society, as they are seen as reliable sources of information.

Example from the Mosquito Alert project

The Mosquito Alert Citizen Observatory has been active since 2014 and is dedicated to investigating and controlling disease-transmitting mosquitoes. It offers an app to report the observation of tiger mosquitoes and yellow fever mosquitoes, as well as their bites and possible breeding sites.

This Citizen Observatory brings together citizens, scientists and managers of public health and the environment to fight against those vectors of Zika, Dengue and Chikungunya. Involving all these actors is possible by making the research results available to them in appropriate ways.

Mosquito Alert periodically offers status reports to the participants and to the authorities in order for them to keep informed on the progress on the research as well on the situation of the mosquitoes and their distribution. On the MosquitoAlert website, periodical news is published, as well as summary reports, and a periodic newsletter is sent to the participants summarising the results and impact of the Citizen Observatory and containing pictures and observations contributed by the citizens as a means to acknowledge their contributions.

I want to ensure sustainability of the citizen observatory after the funding period

by accessing open funding calls

Why is it relevant?

A lack of funding often prevents the continuity of Citizen Observatory activities and the advancement of the maturity of related technical solutions. You may not be aware of available funding opportunities that could facilitate the sustainability of your Citizen Observatory.

How can this be done?

Funding calls related to Citizen Observatories in particular, and to citizen science more generally, can become available in different contexts and at different scales, including European funding (e.g. Horizon 2020, ESA, Horizon Europe), regional, national and multinational grants (e.g. EEA grants), as well as via projects (e.g. open calls by ACTION and CSEOL, or the WeObserve Open Data Challenge) and other international programmes and initiatives.

The citizen science community at large is increasingly well-organised in terms of scanning for and sharing relevant funding opportunities, for example via the mailing lists and websites of regional citizen science associations. Also, there are many ways in which to connect to and collaborate with other Citizen Observatories. These collaborations can provide opportunities to join forces to respond to specific funding calls, while they can evolve to more coherent structures through the creation of partnerships or alliances aiming to leverage new opportunities in the field.

Useful Resources

WEBSITE: Funding and tender opportunities linked to Horizon Europe can be found on the **Funding and Tender Opportunities page** of the European Commission website.

WEBSITE: The European Space Agency **Call for Proposals page** lists a range of funding opportunities across a various topics.

WEBSITE: The NASA **Call for Proposals page** lists a range of funding opportunities across a various topics.

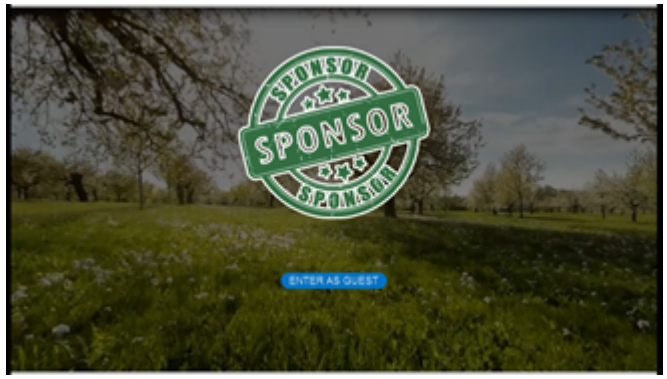
WEBSITE: FundsforNGOs provides a list of upcoming funding opportunities, mostly focused at NGOs

At the same time, this information needs to be tapped into and acted upon by Citizen Observatory leaders and community managers. So it is important to set up some deliberate search mechanisms in your Citizen Observatory team to regularly scan for suitable funding opportunities.

Finally, as many Citizen Observatories are project-funded, their post-project sustainability should be analysed and anticipated from the start of the Citizen Observatory, considering options for continuity for specific tools as well as the Citizen Observatory as a whole.

Example from the Scent project

The Scent Citizen Observatory established a smart toolbox of collaborative technologies and applications that engage citizens in monitoring environmental parameters during their everyday activities. A viable option, stemming from the analysis of different exploitation strategies, that could facilitate the continuity and further use of the realised toolbox, lies in seeking sponsorships. Sponsors can be, for instance, industrial organisations that, as part of their corporate responsibility, want to promote awareness about environmental issues and initiate calls-to-action. The ability of the toolbox components to adapt their graphics to the sponsor (i.e., inclusion of sponsor logo, or other customisations) can further support and sustain the realisation of this model.



You may also be interested in:

I want to ensure sustainability of the Citizen Observatory after the funding period...

...by making project outputs with open access

...by defining a new service

...by moving the infrastructure of the observatory into the cloud

...by collaborating with other Citizen Observatories that have similar objectives

I want to ensure sustainability of the Citizen Observatory after the funding period

by defining a new service

Why is it relevant?

There are a range of business opportunities to consider in which sustaining Citizen Observatories is a goal. However, they are dependent on the Citizen Observatory's focus, maturity, partners and other factors. A Citizen Observatory may create economic value, enhancing data acquisition and creating new services as a result. Yet to ensure continuation, it is a good idea to plan for business model development and innovations in service propositions during the lifetime of the initial funding period.

How can this be done?

Citizen Observatories frequently define and build novel value-added products and services based on the project's data and tools. Business models can support market uptake and innovation as well as ensure that data and resources have a longer life.

- Developing a Business Model

Business models can take time to develop. For instance, during the GROW Observatory project a number of models were considered. Some centred around the data either as a service or as insights into the data from different stakeholders. Alternatively, innovative models around methods and tools, or education, might also be relevant.

Useful Resources

TOOL: The **Business Model Canvas** will help design your business model.

TOOL: Test the fit between your product and service with the **Value Proposition Framework.**

PROJECT REPORT: Flood modelling applications through the use of Citizen Observatories tools and data.

WEB PAGE: The WeObserve **Open Data Challenge.**

CONFERENCE PRESENTATION: Sustainable Development Goals conference.

Look carefully at your Citizen Observatory and consider the following points:

- What products and services have you created that might be marketable?
- What could be the target markets?
- How will you organise the business in terms of a legal entity, do you want to be a charity, NGO, limited company or something else?
- What will be the key activities for the first couple of years of operation?
- Do you have a financial plan ?
- What steps do you need to take to put the plan into operation?

TOOL: The WeObserve MOOC step on how to run an ODC: **Citizen Science Projects: How to make a difference** online course on FutureLearn. **Activity 4.6 Setting up your own Open Data Challenge** and **Activity 4.9 Citizen Observatories and service innovation.**

PUBLICATION: The NESTA Open Data Challenge Series Handbook.

– Determining & Defining a Product Offering

In order to determine a business model, all aspects of the Citizen Observatory's work should be analysed in the context of broad market research. Consider the different products and services that could add the most value to the Citizen Observatory stakeholders (and future customers or partners). This will help you to understand how these can support long-term financial sustainability. That process can involve a number of exercises to assess the numerous assets that are available, the potential market and the financial viability.

– Begin a Service Validation Process

An evaluation of the economic landscape of each service should be undertaken to determine how the service could be scaled up and whether there would be a market demand for it. You can achieve this by paying considerable attention to the strengths, weaknesses, opportunities and threats of each service provision within a project portfolio.

A validation process may include:

- The Service Innovation Lab, using value proposition and business modelling methods and tools;
- Interviews with core Citizen Observatory stakeholders, such as service users, research scientists and policy-makers, to inform the development of your value proposition and business model;

- Desk research to learn about the business landscape (demand for your Citizen Observatory's services and any existing competing services), and to create financial models for your plan; and
- Interviews with stakeholders, including industry leaders, fund managers (including domestic ones) and insurance companies that may be relevant to the service proposition.

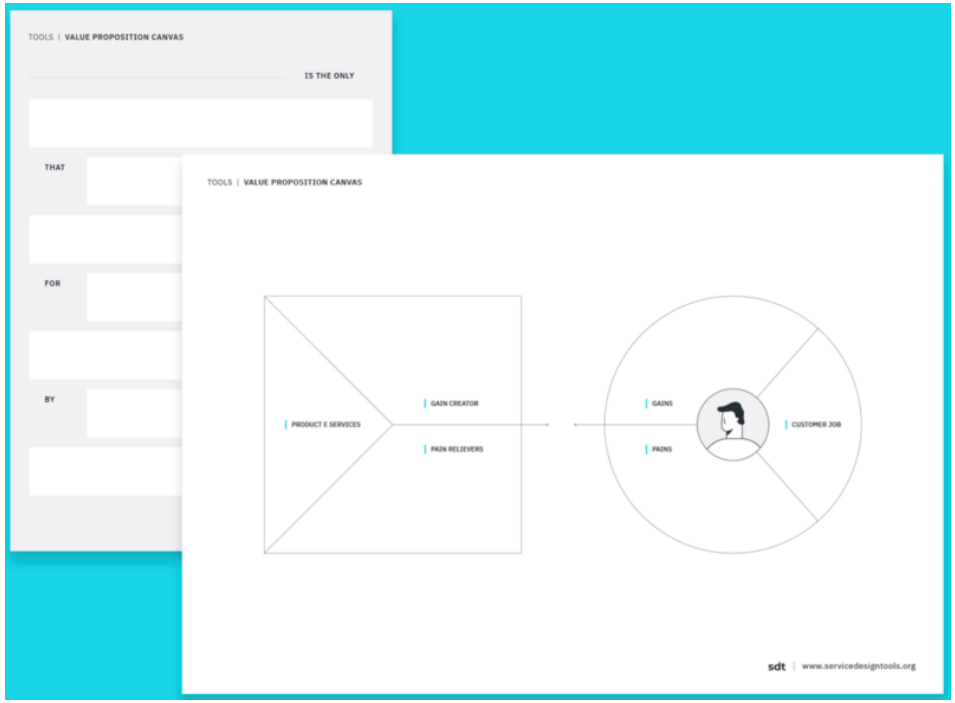
– Begin a Service Innovation Lab

An innovation lab can bring together stakeholders and service users in a collaborative space in order to define the key aspects of a plan for sustainability. In this space, there is the opportunity to use a Service Design framework to formulate concepts such as a 'value proposition' and 'business model'.

For instance, the Value Proposition canvas (below) is a framework that helps participants ensure that the product-service idea fits the market. It enables exploration of the relationship between customer segments and value propositions and highlights the roles involved. It explores the expected pains and gains and how the service will eventually maximise the service value.

Similarly, the Business Model canvas can provide an overview of the service in terms of value proposition, infrastructure, types of customers and financial model.

It can help you to understand what activities are needed in order to build and deliver a service and identify potential trade-offs.



Value Proposition Canvas

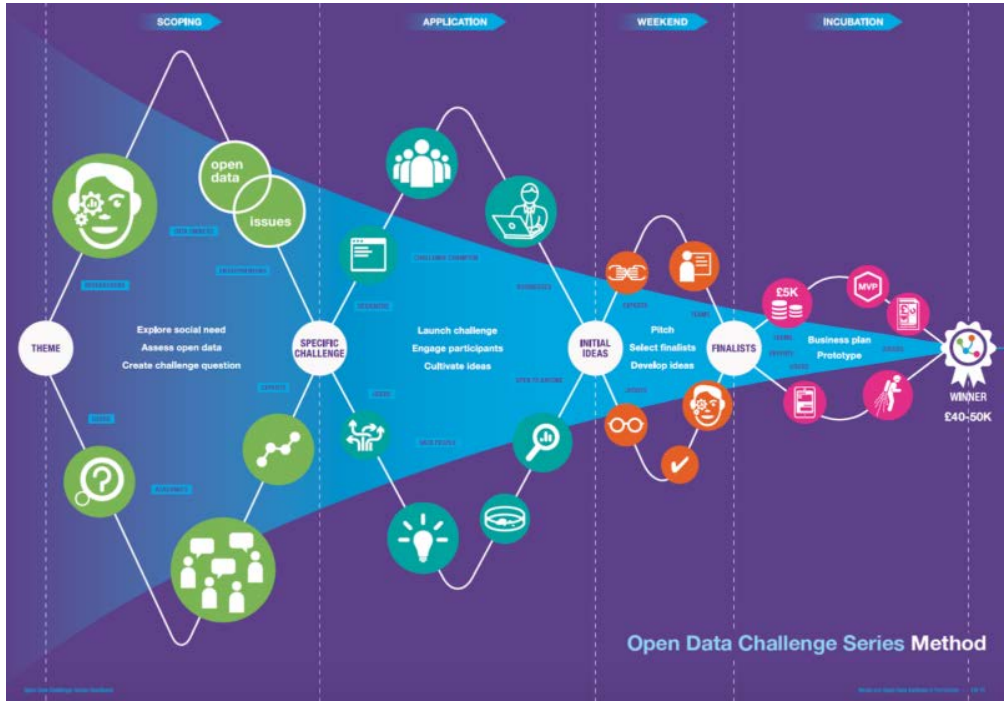
– Consider Data Driven Services and Innovation

Whether your Citizen Observatory is looking to fully sustain itself or to promote targeted innovation activities, there are opportunities to encourage the uptake and use of Citizen Observatory data by industry and SMEs. Initiatives such as an Open Data Challenge (ODC) can demonstrate how data acquired within Citizen Observatory can help private sector businesses address data needs and gaps.

The purpose of this activity is not primarily to engage a large number of people, but rather to create a number of sample applications that might:

To run a successful competition, you might wish to consider the following points and generate appropriate documentation.

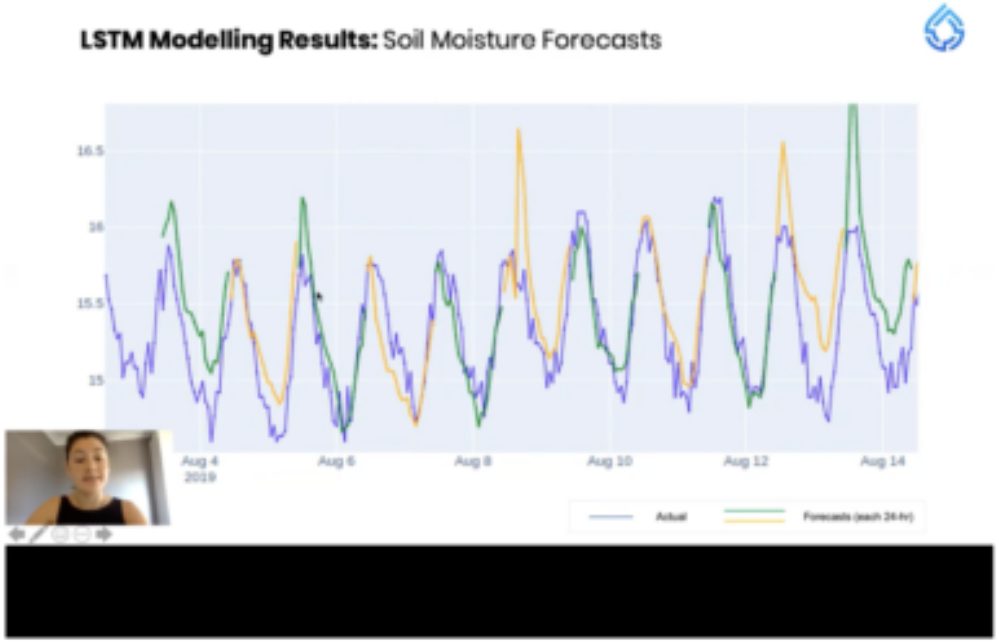
- Competition Call – Create a description of the 'event' and the format. Have you got mentors in mind? What frequently asked questions are likely?
- Look at the data sets you have; are they suitable?
- How are you going to give people access to your data? You might want to produce videos describing the data. You will need to create a licence for your data; you could consider a creative commons licence.
- Who is going to judge your competition? You will need a panel of experts, some of them external to your organisation.
- How are you going to award the winners? Will you hold an event, and who is going to organise it? Is there an opportunity for a demo at a conference or other event?



Planning an Open Data Challenge from the Nesta Open Data Challenge Series Handbook

- How will you publicise the competition? Can you reach parties that may be interested, perhaps through connected organisations, email lists, Twitter, Facebook, etc.? Have you got an organisational website that can carry details of the competition?
- How will you support the competitors? WeObserve set up a Slack channel that all competitors were asked to join. Mentoring was carried out on Slack and through video calls.

- The WeObserve ODC ran a webinar about the data which was publicised in a similar way to the competition, and this was used to draw competitors in.
- Will you create a competition packet for the competitors with an FAQ and details of how they should enter the competition and how exactly what they need to do to satisfy the entry requirements? WeObserve required a code and a 5-minute video explaining the concept.



Video: Gulsen Otcu discusses the HI-TERRA project

An Open Data Challenge was publicised on the WeObserve website, but more importantly, through social media and personal communications with people likely to take part. The challenge was simple: take the data from one or more of the Citizen Observatories and combine it with other data to create a new and possibly commercialised service.

Establishing a modular system architecture that is connected directly with the processes of end-user organisations is another way to facilitate the sustainability of the Citizen Observatory after the funding period. The underpinning mission is to make Citizen Observatory outputs easily replicable and scalable, while at the same time generating economic value and social capital. This is the approach realised by the Scent Citizen Observatory, which introduces a flood management and monitoring service relying on citizen-generated data while being directly exploited by relevant end-users

Lessons learned from the WeObserve Open Data Challenge

The WeObserve team learned some valuable lessons from the Open Data Challenge, most importantly the need to mentor the teams during the competition. We found that the teams with strong mentoring produced the most viable proposals and projects. Not all teams had the experience to produce a product, but nevertheless they could contribute useful ideas. A team brokering exercise could have helped in that situation. Not surprisingly, the exercise produced some unexpected uses of the data, such as food energy calculators for farmers in Nigeria. You never know how external people will be able to use your data! All entries to the competition were open source, so that others could learn from the experience of those taking part.

The competition attracted 44 teams. Nine final entrants provided all the material requested, including details of the project and a short video describing what the team had decided to do. These entries were judged by a panel of citizen science experts, and two were selected to spend 4 months creating a final demonstration project that was presented at the ECSA Berlin conference.

You may also be interested in:

I want to ensure sustainability of the Citizen Observatory after the funding period...

...by making project outputs with open access

...by accessing open funding calls for community groups / research / CS projects

...by moving the infrastructure of the observatory into the cloud

...by collaborating with other Citizen Observatories with similar objectives

I want to ensure sustainability of the Citizen Observatory after the funding period

by moving the Citizen Observatory's infrastructure to the cloud

Why is it relevant?

Citizen Observatories depend on the reaction levels of their users. If it is not possible to clearly estimate the number of infrastructure users supporting the community, the exact hardware requirements cannot be determined. If, at some point in time, more participants start providing observations, performance and reliability issues can emerge. Cloud providers offer 'elastic' infrastructure as a service which can solve this problem. Citizen Observatories can be deployed in the cloud, and the service can be designed to automatically request more resources when there is more demand.

How can this be done?

There are many cloud providers that can offer relevant services for Citizen Observatories. But from a strategic perspective, a Citizen Observatory should consider moving into the European Open Science Cloud (EOSC). The EOSC is an environment for hosting and processing research data that supports EU science. The EOSC was initiated by the European Commission in 2015. It aims to develop a federated environment that cuts across borders and scientific disciplines to re-use research data and software, following the FAIR principles. Since Citizen Observatories have demonstrated their capacity to complement official data sources, they should be part of this comprehensive initiative.

To become a recognised institution by the EOSC, you should register your Citizen Observatory in the EOSC portal. Once this is done, you can register the Citizen Observatory services as EOSC resources. This process will give the Citizen Observatory more visibility among the scientific community.

Useful Resources

REPORT: The **EOSC Interoperability framework** contains a proposal for the management of FAIR Digital Objects in the context of EOSC and a reference architecture for the EOSC Interoperability Framework that is inspired by and extends the European Interoperability Reference Architecture (EIRA), identifying the main building blocks required.

TOOL: **Citizen Science Cloud**: Initially created for the Earth Challenge 2020 initiative, the Citizen Science Cloud is a place where anyone can share and access open, interoperable citizen science data and related applications.

– Select a cloud provider

Currently, the EOSC is not imposing requirements on the infrastructure sustaining a Citizen Observatory. If your Citizen Observatory has not yet been moved into the cloud, it can request cloud access to the EGI Federated Cloud. EGI will determine which member of the federation can best serve the Citizen Observatory in terms of Cloud Compute, Cloud Container Compute or Training infrastructure.

– Secure funding for the associated costs

Cloud providers rent infrastructure to their clients as a business model. Your Citizen Observatory needs to secure continuous funding to pay for the cloud services. Costs will depend on the computer resources reserved as well as the level of usage of the infrastructure. The organisation of successful data collection campaigns can increase the level of use, resulting in unforeseen costs. On the other hand, your Citizen Observatory will save in hardware costs that are necessary to manage a local infrastructure. The Citizen Observatory will benefit from providing a reliable and stable service whatever the circumstances, something very difficult to achieve with a local infrastructure (which can fail unexpectedly).

Example from the Cos4Cloud project

The Cos4Cloud project is developing eleven services. Once these are ready, Cos4Cloud will upload these services to the EOSC as modules, so that any existing Citizen Observatory will be able to choose and install the technological services needed to improve its functionalities. These projects are adopting a common interoperable architecture that will make it possible to allow them to work together and to integrate them in the European Open Science Cloud (EOSC) ecosystem. These services are:

You may also be interested in:

I want to work with data...

...by managing the data

I want to ensure sustainability of the Citizen Observatory after the funding period...

...by making project outputs open access

...by accessing open funding calls

...by defining a new service

...by collaborating with other Citizen Observatories that have similar objectives

- *Cos4Bio (and Cos4Env), a platform that integrates observations on biodiversity (or environmental) from different Citizen Observatories, potentially monitoring an enormous number of observations that are of interest to the expert community;*
- *DUNS (Data Use Notification Service), an innovative system for data-usage tracking and user rewards. This system will serve as a method to evaluate the scientific contributions linked to citizen-observatory data;*
- *MOBIS (Mobile Observation Integration Service), which offers a nice user-friendly interface to get valuable data from smartphone sensors and images;*
- *MECODA, an expandable scripting repository;*
- *FASTCAT (Flexible Ai System for CAmera Traps)-Cloud, an automatic way to propose the species name for a picture;*
- *FASTCAT (Flexible Ai SysTem for CAmeranTraps)-Edge, which automatically pre-processes video streams (or regular snapshots);*
- *Pl@ntnet API, an interface to use the Pl@ntNet identification engine and gain access to Pl@ntNet data;*
- *AI-Naturalist, providing automatic identification tools adapted to Citizen Observatory needs based on machine learning;*
- *AI-GeoSpecies, which shows potential species to be observed in a set area. Works on a scale of 50 thousand species on a Europe-wide level;*
- *Biodiversity-DL, a training set on a particular group of living organisms on-demand; and*
- *Authenix, which allows registered applications and services to log in to multiple digital platforms using one authentication GDPR-compliant service*

I want to ensure sustainability of the Citizen Observatory after the funding period

by collaborating with other Citizen Observatories that have similar objectives

Why is it relevant?

Citizen Observatories are typically intended to run long-term, but often they are initially set up for a relatively short time frame without secure follow-up funding. Joining forces with other Citizen Observatories can help address this sustainability challenge.

How can this be done?

Right from the start, let others know what you are working on and find other Citizen Observatories to collaborate with. Find out how to do this in the sections below. Put your own initiative on the WeObserve Citizen Observatory Landscape Map and engage with other Citizen Observatory practitioners via Communities of Practice (CoP) and other working groups. This will help you forge relationships across Citizen Observatories to learn from each other, develop strategies together, and create networks to collaborate on future funding calls to be able to continue your successful activities.

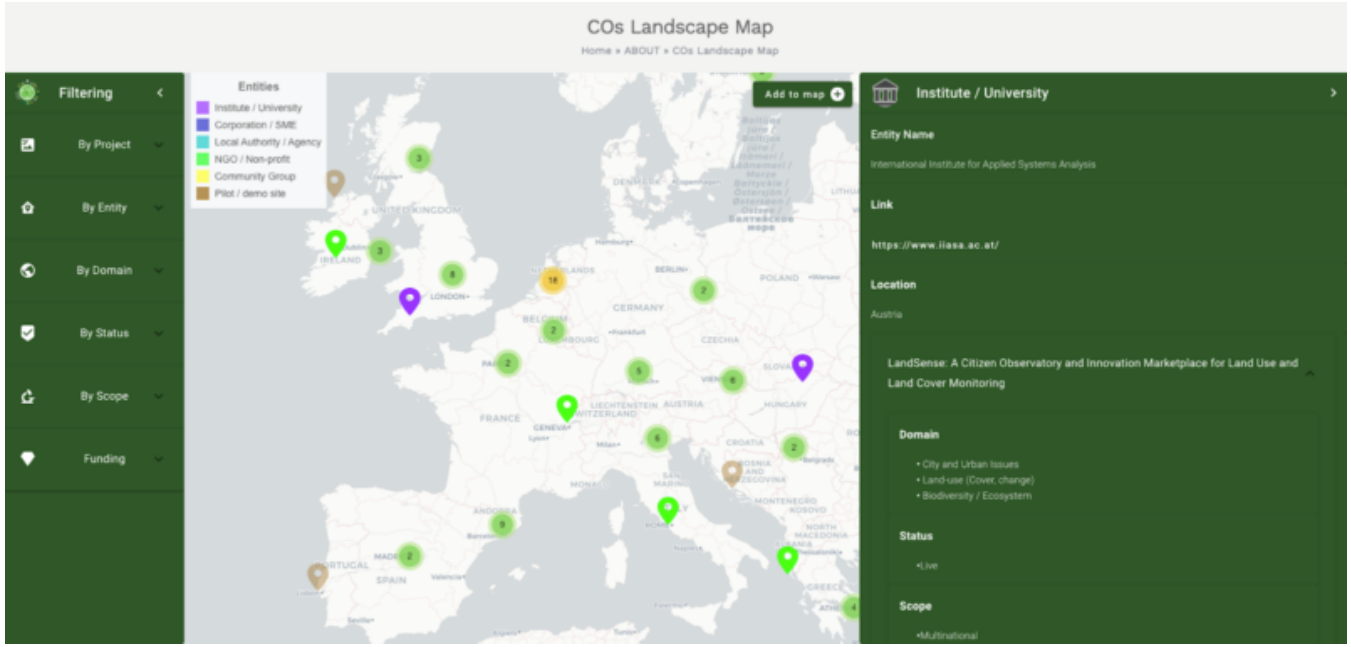
- Add yourself to the map

Increase your visibility as a project and allow others to get in touch with you by adding yourself to the Citizen Observatory Landscape Map. You can also use the map to find other interesting projects that may be relevant for you to connect with.

Useful Resources

TOOL: The **WeObserve Landscape Map of Citizen Observatories** presents a visualisation of Citizen Observatories (and related organisations) across Europe.

COMMUNITIES: The **WeObserve CoPs** are made up of practitioners, citizen observers, policy makers, scientists and researchers, among others, and aim to consolidate practice-based knowledge of Citizen Observatories, share information and resources, and further develop best practice guidelines and toolkits for Citizen Observatories.



Screenshot of Citizen Observatory Landscape Map on www.weobserve.eu

PROJECT REPORT: D2.8 Final WeObserve CoP report.

WORKING GROUPS AND CoPs: There are many other communities dedicated to those interested in Citizen Observatories and citizen science:

- **ECSA working groups**
- **CSA working groups**
- **ACSA regional chapters**
- **The CSGP Citizen Science and Open Science CoP**

– Express your interest and join the WeObserve Communities of Practice

So far, four WeObserve CoPs have been established:

- The **Impact CoP** inventories methods for capturing the impacts of Citizen Observatories on governance, captures Citizen Observatory impact stories, and provides guidance on Citizen Observatory impact assessment for the Impact CoP members and beyond.

- The **Co-design** and **Engage CoP** facilitates knowledge sharing on co-designing Citizen Observatories and engages stakeholders to learn about common successes and challenges across projects.

- The **Interoperability CoP** adopts data quality, curation and preservation of Citizen Observatory data, addresses privacy and licensing issues, and conducts interoperability experiments within the Open Geospatial Consortium (OGC). The first IE experiment report has informed data architectures of the Earth Challenge 2020.
- The **SDG CoP** connects citizen science practitioners and researchers, National Statistics Offices (NSOs), UN and international agencies and data/stats communities to exchange knowledge and resources to demonstrate the value of citizen science data and impact for SDG monitoring. The SDG CoP has comprehensively mapped citizen science projects against the SDG indicator framework. Results from the study have been taken up at high-level organisations, such as the UN Science-Policy-Business Forum.

While the Horizon 2020 funding of WeObserve ends in March 2021, the CoPs will continue as long as they provide value for the groups and chairing can be secured via other projects or new funding being generated. You can sign up to the CoPs here.

– Join other regional or global working groups

Several regional and transnational citizen science associations exist that run specific working groups, such as the Citizen Science Association in North America (CSA), the European Citizen Science Association (ECSA), or the Australian Citizen Science Association (ACSA). The GEO Citizen Science Community Activity works to elevate the value of citizen science communities and data from local to global scales. The Citizen Science Global Partnership (CSGP) is a global effort to bring together the citizen science community at large and provide concerted actions towards global policy and other important domains.

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...by accessing open funding calls

...by defining a new service

...by moving the infrastructure of the observatory into the cloud

Lessons learned from the WeObserve project

WeObserve has launched and run four highly successful CoPs and learned a great deal on the barriers and *opportunities of such knowledge exchange and networking activities. In this video, CoP chairs Uta Wehn (IHE Delft), Joan Maso (CREAF) and Dilek Fraisl (IIASA) provide their insights and lessons learned, recorded during the ECSA conference in Sept 2020.*

www.weobserve.eu

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