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The Platform for Sharing, Initiating and Learning Citizen Science in Europe

PDF of the training module "Introduction to Citizen Science for Journalists"

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INTRODUCTION AND WELCOME (2 MINUTES)

- Introduction from the course tutor (2 minutes)

❖ Welcome to the course and outline (2 minutes)

Welcome to the Introduction to citizen science for journalists. This short introductory course will help you to learn some of the important aspects of citizen science. You will see historical and contemporary examples of activities that fall under citizen science; you will be introduced to the major issues that will come up when discussing citizen science - such as data quality or motivations of participants; and you will learn about the broader impacts of citizen science.

In Moodle you will find a short video in this section. Here you can read the video transcript:

Welcome to the Introduction to Citizen Science course. My name is Muki Haklay and I am a professor at University College London where I co-direct the Extreme Citizen Science group. Together with Claudia Fabó Cartas and Andrea Troncoso from the European Citizen Science Association; and Lucie Steigleder from Ecsite, the European network of science engagement organisations, we have prepared this course for you. The term "citizen science" is probably new to you, and we hope that by the end of this hour and a half training unit, you will feel that you know what it is about. You will learn about its history, the main issues that you might come across when reporting about it, some of the terminologies and their explanation, and where you can find further information. ***All the material on this course is free for reuse, as long as you provide attribution, so feel free to use it in your reports****. You can find more information on the different sections in the "Sources". We hope that you'll find the course beneficial and interesting!*

Recording mountain goat survey results for the high country citizen science project. Siyeh Pass. (Photo by GlacierNPS on Flickr)

❖ Course content as a PDF

In addition to the online content, we provide a PDF with the content of the whole course. You can use all the text in this PDF, as long as you provide attribution to the EU-Citizen.Science platform. The material is shared under Creative Common 4.0 international licence. The recommended attribution is:

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CITIZEN SCIENCE IN FIVE STORIES (15 MINUTES)

❖ Introduction to the section (1 minute)

In this section, we introduce you to five stories about citizen science. By using concrete examples, you will be able to see that this is a practice that has been going on for a long time but has a new form due to recent development. The five stories are short and are introduced to you as an interactive slideshow that you can look through at your own pace.

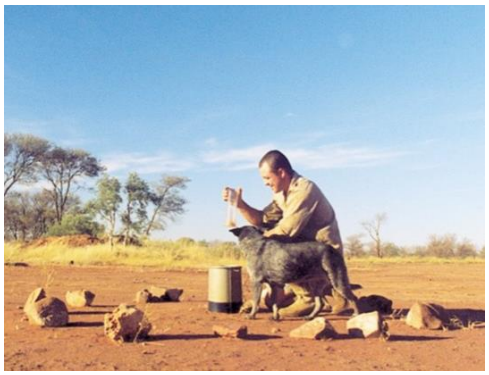
❖ "Come rain or shine" - The volunteers that make weather forecasting possible (2.5 minutes)

In this presentation, you'll learn about our first hero – Rick Grocke and his weather observation effort.

Slide 1 − Rick Grocke measuring precipitation

Meet Rick Grocke. In 2000, he lived at the Tanami Downs cattle station in the Northern Territory of Australia. Tanami Downs received 204.2 millimetres of rain during an all-time high event in 2009, but usually, it is a fairly dry place.

We probably know these facts about Tanami Downs thanks to Rick and other volunteers in the area that every day check how much water their rain gauge gathered. Every day they check meteorological conditions, such precipitation or temperature, and report to the Australian Bureau of Meteorology.



Volunteer rainfall observer Rick Grocke checks the rain gauge at Tanami Downs cattle station in the Northern Territory of Australia (Photo by WMO)

Slide 2 - Weather volunteering and citizen science

Volunteer measuring the rate of evaporation of water using a Piché evaporimeter; behind is a traditional "Stevenson screen" instrument housing (Photo by WMO)

A stevenson screen (a weather observation station) on a slope of a mountain. (Photo by Richard Allaway on Flickr CC-By)

Rick is part of a global network of weather volunteers that contribute with their observations to their national meteorological service. Observing the weather and reporting it regularly is an activity that is part of citizen science. The people who take the measurements and report them are not trained as scientists. They are people who live in an area and for one reason or another, took over the management of a weather station and got into the habit of collecting and sharing the facts as they find them.

Some people do that for a very long time - for example, an Irish man, age 93, received an award for measuring rainfall daily for 56 years.

Slide 3 - History of volunteering

The practice of wider participation in weather observation has a long history. In many countries around the world, the regular recording of meteorological information such as temperature or rainfall using scientific tools and approaches have started in the middle of the 19th century. In many cases, they recorded their observations on cards and in diaries, but with the growth of communication means - first the telegraph, then the telephone and the internet - the observations are being shared rapidly.

Slide 4 - The need for volunteers

Knowing what the weather will be like is very important for a whole range of human activities - from putting the washing out to launching a mission to Mars. Weather volunteers solve an important problem for the scientists who create weather forecasts - the need for detailed information from a very large area. Local variations and the inherent unpredictability of

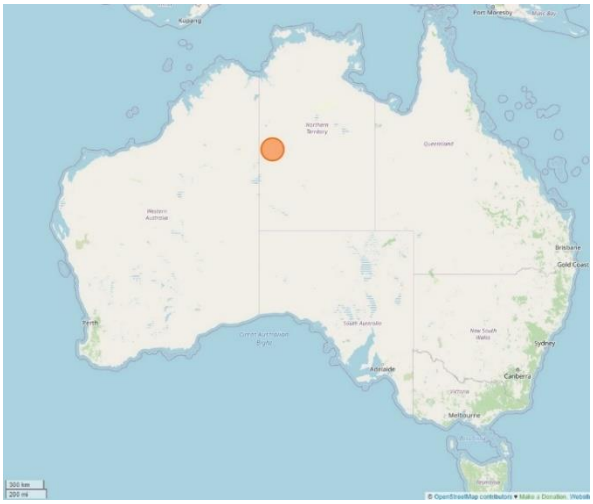
the Earth's atmosphere means that regular observations are necessary to be able to create reliable predictions.

Even with automated stations, there is a need for maintenance, so having volunteers that record the data and share it is very effective and increases the accuracy of the system. This is typical of other aspects of environmental monitoring where a large and distributed group of observers is needed.

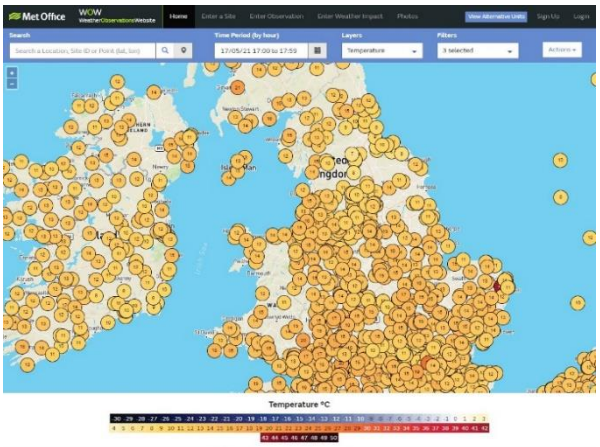
Slide 5 - Current activities in weather observation

Weather observation volunteers remain central even today, as they provide crucial information that supports the forecasting services. Sometimes, that will include owning an automated weather station and linking it up to the internet, and sharing the observations that the station creates with aggregating bodies.

For example, the UK meteorological office collects 13 million observations each month on its Weather Observations Website (WOW).



The location of Tanami Downs - a remote place (Map © OpenStreetMap contributors)



The UK Met Office Weather Observation Website (May 2021)

❖ Observing the first satellites (2.5 minutes)

In this story, we will learn how Fred L. Whipple, the director of the Smithsonian Astrophysical Observatory organised volunteers to watch the first human-made satellites.

Slide 1 - Introduction

Our second story is about Fred L. Whipple and how, with a group of volunteers, he helped spot the first human-made satellite - the Sputnik - in 1957. Fred was a professor of Astronomy at Harvard and in charge of the Smithsonian Astrophysical Observatory. We are in the middle of the 20th century, after the Second World War which brought with it a big change to the way

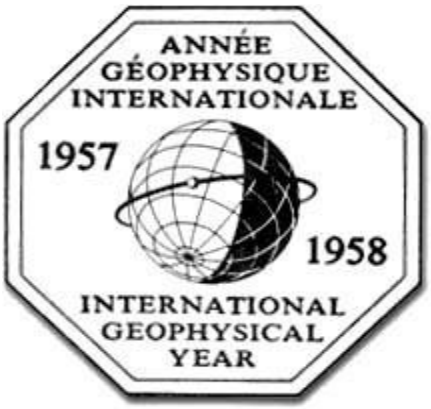
science is run. Science became part of the things that the state is investing in, and there was a new era of “Big Science” - large projects that require very large investment and the involvement of hundreds or even thousands of scientists.
One of the symbolic events that introduced this new era of science was the International Geophysical Year.

Fred L. Whipple in 1927 (Public domain)

Slide 2 - The International Geophysical Year 1957

The International Geophysical Year (IGY) ran from July 1957 to December 1958 (so not exactly a year!) and it was an opportunity for international collaboration between scientists, despite the Cold War - so there was collaboration of East and West countries. During the year, many areas of research were explored: Earth Science, Meteorology, Oceanography, Seismology to name a few. The IGY was very successful and many of its achievements from it continued to shape science, such as the way that Antarctica is shared between countries for peaceful purposes.

One of the most important achievements of the IGY was the launch of a human-made satellite.



Official emblem of the IGY (Public domain)

Postage stamp from United States of America (USA) in the Geophysical Year Issue of 1958 (© Mystic Stamp Company)

Slide 3 - Operation Moonwatch

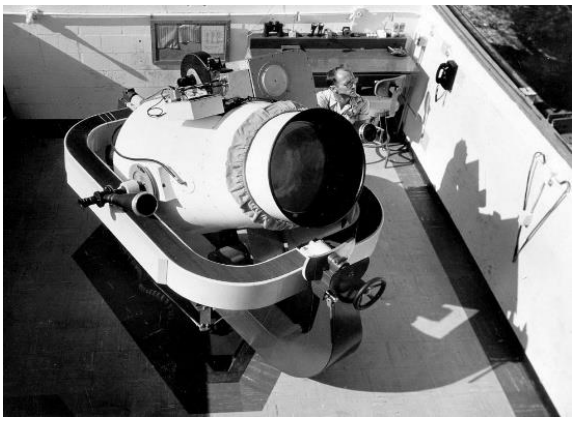
The plans for launching satellites had been developed for several years, as a result of the development of rocket technologies. Therefore, there was a need to monitor them and understand their trajectories and paths. Considering that this was during the Cold War, this

was a very important task - despite the promises that these satellites will be used only for non-military purposes. While an expensive satellite tracking system was in development, Fred L. Whipple suggested that volunteers can be trained to observe satellite paths and started creating the network in 1955. He called this Operation Moonwatch.

Slide 4 - Amateur satellite observers

The system worked with amateurs sitting in a row, and when a satellite (or a plane) fly over, they can record the direction and speed of the object. By October 1957, there were 200 teams. When, to the shock of the USA, the Sputnik-1 satellite was launched on 4th October 1957, the more complex system was not ready to use, and it was Moonwatch volunteers who spotted it first. Operation Moonwatch continued until 1975.

Moonwatch is another example of citizen science in which a scientist comes up with an idea and recruits a large and geographically distributed network of observers to record and share information. As with the interest in the weather, there is a long history of amateur astronomers and the concerns over the Cold War, it was possible to recruit people and retain them over a long time.



Baker-Nunn Camera, one of the world's most sensitive devices at the time for observing artificial satellites. A network of twelve tracking stations equipped with such cameras was maintained by the Smithsonian Astrophysical Observatory. (Public domain)

Volunteer satellite trackers in Pretoria, South Africa, for Smithsonian Astrophysical Observatory's Moonwatch Network. (Public domain)

❖ From buckets of resistance to balloon photography of oil spill (2.5 minutes)

Our third story is about communities that have to deal with a polluting factory as a neighbour.

Slide 1 - Environmental Justice

Louisiana Bucket Brigade - Anne Rolfes on the far left (Photo by Louisiana Bucket Brigade)

Another important activity in which ordinary people use scientific tools are cases where there is an environmental justice problem. For example, when the people living near the fence of a petrochemical factory experience a high level of pollution. How can they monitor pollution events and make sure that the authorities take care of them? Meet Anne Rolfes from the Louisiana Bucket Brigade and Dorothy Jenkins from the Concerned Citizens of New Sarpy. They are using an instrument that is named “the bucket” to collect air samples, which can then be sent to the laboratory and analysed for their chemical composition.

Slide 2 - The bucket

The bucket emerged at the end of the 1990s when the lawyer Ed Masry (who is famous for the Erin Brockovich film) funded the work of an engineer that will transform an air sampling device that cost many thousands of dollars into something that can be used more widely. After some iterations of the original design, the bucket was born and adopted by a range of community science groups who were dealing with locally polluting factories. The quality of the process is high, and the US Environment Protection Agency accepted the results of such studies.

The organisations that Anne and Dorothy were running in the early 2000s have successfully used the bucket in their work.

Since government agencies have failed to conduct extensive air quality testing in Arvin, Gustavo has organized the "Bucket Brigade", a group of community members who've been trained to use a special bucket outfitted with a bag and hose. (Photo by Sarah Craig/Faces of Fracking on Flickr)

Slide 3 - BP oil spill 2010

When in 2010 the BP Deep Horizon rig disaster polluted the Louisiana coast, one of the members of the Louisiana Bucket Brigade, Shanon Dosemagen,

teamed up with people experienced in photography using helium balloons. They were able to carry out monitoring of the impact of the spill which usually is not possible for community organisations. This effort led to the creation of "Public Laboratory for Open Science and Technology" (or Public Lab), an organisation that is dedicated to creating low-cost environmental monitoring tools.

Slide 4 - Community science

The inventiveness of Anne, Dorothy, Shannon and other environmental justice project participants is different from our previous examples. The issue of concern is not coming from scientists but members of the community, but like in the case of weather monitoring or amateur astronomy, there is a need for affordable equipment that can produce high-quality results. The equipment and the data are linked to what the communities care about and their local context.

Slide 5 - Community science

We can also see this as part of a trend towards "Do-It-Yourself" (DIY) science. Instead of buying expensive scientific equipment, the interested people create the equipment themselves. There are examples of DIY science in environmental monitoring, but also in biology, chemistry, and physics.

Oil Spill website (Photo by Jeff Warren on Flickr)

Balloon Mapping by Public Lab (Photo by Public Lab CC-By-SA 3.0)

DIY Bio Lounge at Art Laboratory Berlin (Photo by transmediale on Flickr)

❖ Chris, Kevin, and Hanny and the Galaxies (2.5 minutes)

In our fourth story, we see how thousands of participants helped a PhD researcher to classify a million images of galaxies.

Slide 1

In July 2007 in a pub in Oxford, Kevin Schawinski, who was doing his PhD in astrophysics met a friend, Christ Lintott for a pint of beer. Kevin had a challenging week. To prove a theory about the formation of galaxies, he needed a very large dataset of galaxies classified according to their shape. He classified 50,000 images of galaxies from the Sloan digital sky survey.

(Photo by Stephane Farenga on Flickr CC-By-2.0)

To get to the million classifications that he needed, he would need to spend months doing only this, before the analysis can commence. Realising that there is a wide group of people that are interested in galaxies and happy to support scientific efforts, they saw an opportunity.

Slide 2

A year earlier, NASA started a very successful citizen science project called Stardust@home, in which volunteers used a virtual microscope in their web browser to classify images of interstellar dust. Kevin and Chris, who was already an established science communicator, set up a website. The website contained the images of the galaxies that Kevin needed and allowed volunteers to classify an image. Within the first 24 hours of operation, the website received 70,000 classifications in an hour. The classification was also better - each image was classified by multiple people.

Photo by Free-Photos on Pixabay

The Galaxy Zoo website was born. Some volunteers, such as Alice Sheppard, helped by assisting in moderating the discussions among volunteers and community management.

Slide 3

Galaxy Zoo was mostly designed to allow scientists to set up the classification problem that they need to solve, with volunteers helping with the work itself. This can be called crowdsourcing. Yet, Galaxy Zoo provided opportunities for citizen scientists to make discoveries by themselves. For example, when one of the volunteers, Hanny van Arkel, saw a galaxy shape that she hadn't seen before she started asking questions about it. Eventually, it was accepted as a discovery of a new type of observed object. It was published in the academic literature as “Hanny’s Voorwerp” (Hanny’s object).

Hanny van Arkel, school teacher from Heerlen, the Netherlands. She discovered "Hanny's Voorwerp" when participating in the Galaxy Zoo (Photo by Vysotsky on Wikimedia)

Other discoveries were made by a group of participants, through sharing and questioning the things that they saw. Maybe volunteers were the first humans that looked at the images, as all the process was automated up to this point.

Slide 4

The success of Galaxy Zoo led to the creation of a range of projects. All of them rely on the sharing of some media - image, audio or video - and asking volunteers to help in carrying out a task or a classification. There are now over a hundred projects on the Zooniverse platform - from clicking on penguins to help polar research to count them, to looking at historical text on papyrus and transcribing them. Over 1.6 million people have registered and used the system over the years.

Hanny's Voorwerp (Photo by Sloan Digital Sky Survey on Flickr CC-By)

The Zooniverse platform also provides an example for potential collaboration between humans and machines by using artificial intelligence. For example, when a classification that is flagged as uncertain by the algorithm, can be passed to the human participant.

❖ Patient, heal yourself! (3 minutes)

Slide 1 - Self monitoring

Sara uses a range of wearable technologies to record her condition, track symptoms and customise her treatments of Parkinson's disease. Then she shares her experiences with other patients online and encourages them to take control of their own healthcare. (Photo by Angela Moore on Flickr CC-By-NC-ND)

Modern medical treatment is complex. It involves multiple medicines and while they are tested individually, their interactions and their relevance to a specific patient can be predicted statistically - but there are variations. Especially in chronic illness and in rare diseases that affect small groups of patients, there is a growing trend of patients and their carers taking an active role in the management of the condition, using scientific tools.

The growth in tools such as smartwatches or activity monitoring of different forms is important here. The patients utilise the abilities of mobile phones to act as sensing devices to record and monitor their condition. This is part of a phenomenon of "self-quantification" where people record, sometimes in a detailed way, their condition, and share the information with other people with the same condition so they can learn from the shared experience.

Slide 2 - Sara's story

Here a video about Sara's story is displayed. You can watch the video or read the transcript below.

(Courtesy of the Science Museum with permission from Science Museum Group)

My name is Sara Riggare, I live in Stockholm (Sweden) and I do self tracking to support my Parkinson's disease. Parkinson's disease is a very complex disease that is caused by lack of the neurotransmitter dopamine in my brain. To manage it, I take a lot of medication.

To keep my hands from not stiffening up, I try to do crocheting or knitting to keep them as agile as I can. I also do exercise to keep my symptoms at bay.
I started tracking basically because I don't see my doctor very often. I see my neurologist one hour per year and the rest of the year I spend in self-care. That's when I can manage

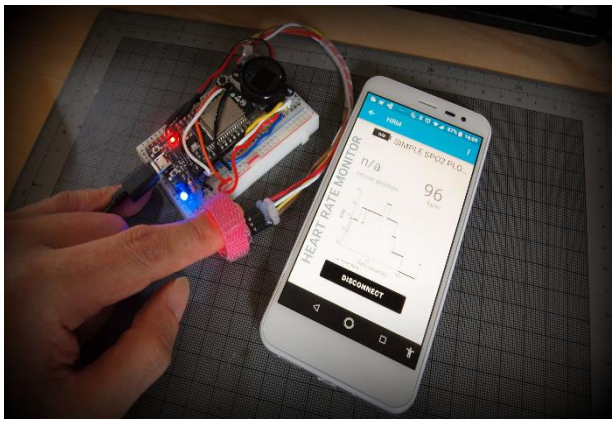
and take care of myself, the best way I can. To do that, of course it's easier to measure to know if you improve or not.

To track my activities I use my smartwatch or my smartphone. I track when I have a reason for tracking, so I track maybe when I change the medication or I think I have a new symptom. I don't only use technology and devices, I also just observe and make notes using pen and paper or in files on my computer.

My doctor is very interested in the way I collect data because he finds it gives us more information for forming a joint decision about my treatment. In terms of understanding the patterns of the disease, the data is really essential. There are lots of self-trackers in different countries and we share information, we share methods. We have a lot of common questions and common issues to deal with.

Self tracking is a very powerful tool for the future of healthcare. My being able to do almost everything I want to do, in spite of having Parkinson's, is due to the way I've observed and optimized my treatments.

Slide 3 - DIY health



DIY Wireless Pulse Oximeter by MAX30102 (Photo by Coniferconifer on Flickr CC-By 2.0)

Sara's story and similar achievements by patients who are using social networks and dedicated websites (such as PatientsLikeMe or OpenHumans) demonstrate an important facet of citizen science. While in the past it was only affluent gentlemen who could afford to be scientists, today the devices, instructions online, and the ability to connect and learn from others allow many more people to do so. The number of people that are involved in "Do It Yourself" (DIY) science is still very small - there are knowledge, time, motivations, and skills barriers. Yet, they lead the way and make it possible for others to join in and manage their conditions.

❖ Summary (1 min)

The five stories that we have seen in this section provide us with an overview of the activities and forms of participation that citizen science offers. We have seen how the history of non-professional researchers in science goes a long way and predate the development of the modern science system. We also noticed that even within large-scale scientific efforts, such as the International Geophysical Year, there was a space for citizen scientists to join and

contribute in a meaningful way to the scientific effort. Galaxy Zoo provides us with a demonstration of large scale crowdsourcing activity that is based on the Web and fast connectivity (to download those beautiful images of galaxies). The stories also show the role of individuals - Hanny van Arkel or Sara Riggare are demonstrating how much people can be involved in research. Personal issues, such as managing your health, and community issues, such as dealing with a polluting factory nearby, are motivators for starting projects. In other cases, it is more about helping scientists and society at large. This wide range of activities is common to citizen science - it can take many shapes.

❖ Self assessment quiz - select the right option (optional - 2 minutes)

Drag the words into the correct boxes

Operation MoonWatch, 19th century, Galaxy Zoo, self-quantification, rain gauge, rainfall, the bucket

Citizen science, a term to describe the participation of members of the public in research, has a very long history and multiple forms. For example, in the area of weather reporting, networks of observers emerged in the middle of the [ ] in different places across the world. Volunteers measure [ ] and temperature daily and report it to regional or national bodies. There are also examples from observations of animals, birds, and plants that also go back hundreds of years.
Watching the night sky is another human activity with deep roots. This interest is the basis for different citizen science projects - such as in the 1950s the creation of [ ] to track satellites, or the [ ] project in which volunteers classify millions of images of galaxies online. Citizen science projects are not always started by scientists who ask the public to join, but sometimes when a community lives near a polluting facility, they can use a DIY air sampling tool -- to provide evidence to the authorities. DIY is also used by people who monitor their health condition, and this is called [ ].
There are also very different instruments and technologies that are used in citizen science - weather monitoring can still be based on using [ ] and checking it every day, while monitoring your health can involve building up a DIY instrument.

Answers: 1. 19th century; 2. rainfall; 3. Operation Moonwatch; 4. Galaxy Zoo; 5. The bucket; 6. self-quantification; 7. rain gauge

TERMINOLOGY AND CLASSIFICATIONS (20 MINUTES)

❖ Introduction to the section (2 minutes)

In this section, we introduce you to common terms used in the field of citizen science to assist the process of learning about it. The content of this section is separated into two segments: In the first one, we will provide you with definitions and explanations of some

main terms that are being used to describe citizen science, and some of the issues that arise with these terms, e.g. the term “citizen” in the US. In this segment you will find the terms that we deem essential to know about to find your way in the field of citizen science. This segment is separated into part A and part B.

In part A we start with some definitions of citizen science focusing on the contribution of citizens, and their role and involvement. Then we move to the "citizen science vs. community science" debate, over to terms used to name participants in citizen science projects before finishing with open science. In part B we introduce many new terms such as volunteer thinking, DIY Science, participatory sensing, and extreme citizen science by looking at three different citizen science typologies.

The second segment is optional and provides a list of other terms for more reference in the form of an accordion so you can click and choose what you would like to expand on. Terms described are citizen observatories, BioBlitz, FabLabs and Science Shops among others.

The used sources will be collected at the end of the course and are also available in the downloadable pdf.

❖ Main terms of citizen science - Part A (8 minutes)

Slide 1 - Citizen Science (1)

Citizen science

As the five stories in the last section show, a wide range of activities can be called citizen science – a practice that has been going on for a long time. The Oxford English Dictionary added the term **citizen science** in 2014 defining it as “scientific work undertaken by members of the general public, often in collaboration with or under the direction of professional scientists and scientific institutions”. However, the term was initially coined in 1995 by sociologist Alan Irwin who defined citizen science as “developing concepts of scientific citizenship which foregrounds the necessity of opening up science and science policy processes to the public”. Shortly after, in 1996, Rick Bonney, an ornithologist, provided another meaning of the term focusing on the contribution of scientific data by citizens. This meaning focuses less on the democratisation of knowledge production and highlights the more participatory strand of the term. The concept of **crowdsourcing** is used within this context to describe finding a way to engage a (very) large number of people in a project.

Since the 2000's, citizen science has become an emerging area of research and practice. Examples of it are found in different scientific disciplines that interpret the term slightly differently. Therefore, citizen science comes with dynamic standards, methodologies, theories

and techniques that change over time. Providing a universal definition of what is and is not citizen science proves very challenging.

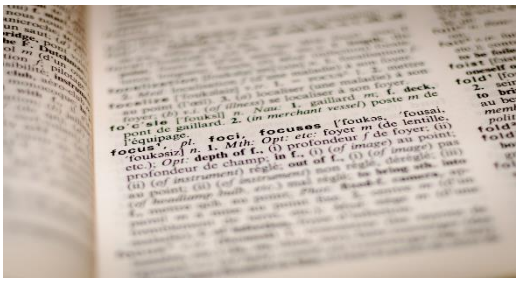


Photo by Romain Vignes on Unsplash (CC-BY)

Slide 2 - Citizen Science (2)

To exemplify, a chapter on "What is citizen science? The Challenges of Definition" in a recently published co-authored book, "The Science of Citizen Science", lists 34 selected definitions of the term. Here are three more definitions from this list that show how citizen science can be interpreted, each highlighting a different aspect of it. Imagine that there are at least 30 more different definitions in this list alone!

- On how citizens contribute: "Citizen Science refers to the general public engagement in scientific research activities when citizens actively contribute to science either with their intellectual effort or surrounding knowledge or with their tools and resources." (White Paper on Citizen Science for Europe, 2014)
- On what their role is: "Citizen science projects actively involve citizens in scientific endeavour that generates new knowledge or understanding. Citizens may act as contributors, collaborators, or as project leader and have a meaningful role in the project." (European Citizen Science Association, 10 Principles of Citizen Science)
- On where they are involved: "Citizen science entails the engagement of volunteers in science and research. Volunteers are commonly involved in data collection but can also be involved in initiating questions, designing projects, disseminating results, and interpreting data." (United Nations Environmental Programme, UNEP, 2019)

Photo by Vlad Tchompalov on Unsplash (CC-BY)

Slide 3 - From citizen science to community science and back (1)

From citizen science to community science and back

Not only are there plenty of interpretations of the term citizen science, but the use of the word citizen in the term itself might prove problematic. While citizen in citizen science was first used

to distinguish professional or trained scientists from untrained scientists, most often the term citizen is used to refer to those that have recognised citizenship status (nationality) of a sovereign state.

Enjoying the legal status of citizenship is in most cases not at all relevant to participate in a citizen science project. However, the term citizen can prove problematic because people that are not citizens of a country might not identify with or feel recognised by this term and, therefore, do not identify with being called a citizen scientist or by doing citizen science – and thus might feel excluded. Especially in the US, many people perceive the term citizen to exclude those without citizenship status.

Slide 4 - From citizen science to community science and back (2)

In an attempt to being more inclusive, a number of organisations and groups in the US have changed the terminology they use to describe their projects and programmes and shifted to calling them community science. However, these terms are not 100% interchangeable; community science has a backstory of its own.

Image of Gustavo, who has organised the "Bucket Brigade", a group of community members who've been trained to use a special bucket outfitted with a bag and hose to conduct air quality testing. (Photo by Sarah Craig/Faces of Fracking on Flickr (CC BY-NC-ND 2.0))

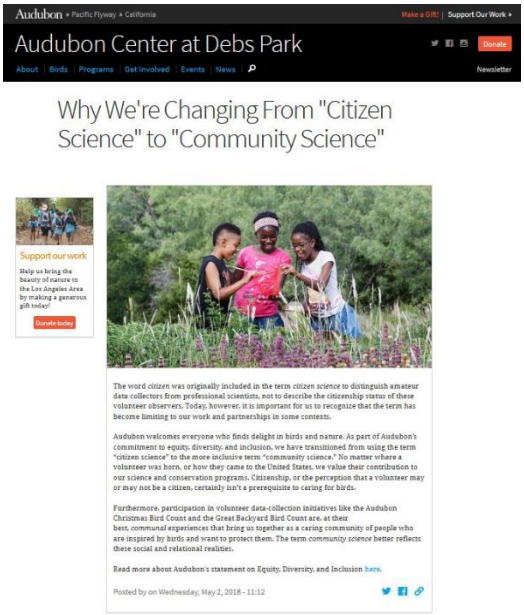
Community science is used to describe projects that are carried out as part of local, everyday settings, to address local concerns and needs, often related to environmental injustices and public health issues. Activities or projects that fall within community science have a strong bottom-up element and are often initiated by a group or a community rather than by professional scientists.

Examples of community science were introduced in one of the stories in the last section. These are the Louisiana Bucket Brigade and the work of the Public Lab. In the Louisiana Bucket Brigade, the community initiated the project, collected evidence of air pollution incidents, and sent its samples to an accredited laboratory to analyse. Therefore, professional scientists had a role here, but not the primary one.

Slide 5 - From citizen science to community science and back (3)

While some people might feel more comfortable with the term community science than with citizen science or use it to be more inclusive, community science emerged in a certain context as it is linked to social justice. Using the term for something that is not community science – co-opting it – might be doing more harm than good, e.g. community science is already

underfunded, so distinct terminology is important to secure funding so community science projects do not fall within the big umbrella of citizen science.



Screenshot of the webpage of the Audubon Center at Debs Park in California on their shift from 'citizen science' to 'community science' at their website.

The terms citizen science or citizen scientist are widely spread and you can feel confident using them. Nonetheless, it is good to know that a group of people, based mainly in the US, has raised this issue.

Slide 6 - Citizen scientist, volunteers…? (1)

Citizen scientists, volunteers…?

It is important to pay attention to the terminology used in citizen science. The goal of citizen science is to engage the public in science and the words we use, especially the ones that describe those that are involved in it, have an effect on how participants view their contribution and feel about it and themselves. The image on the right taken from an article by M V Eitzel and colleagues illustrates examples of how commonly used terms to describe those involved in citizen science can be negatively interpreted. M V Eitzel and colleagues point out in their article that different terms serve different goals and are appropriate for different audiences, e.g. policy-makers or funders, academics, not yet involved participants in a project, etc. Terminology is also field and country-dependent.

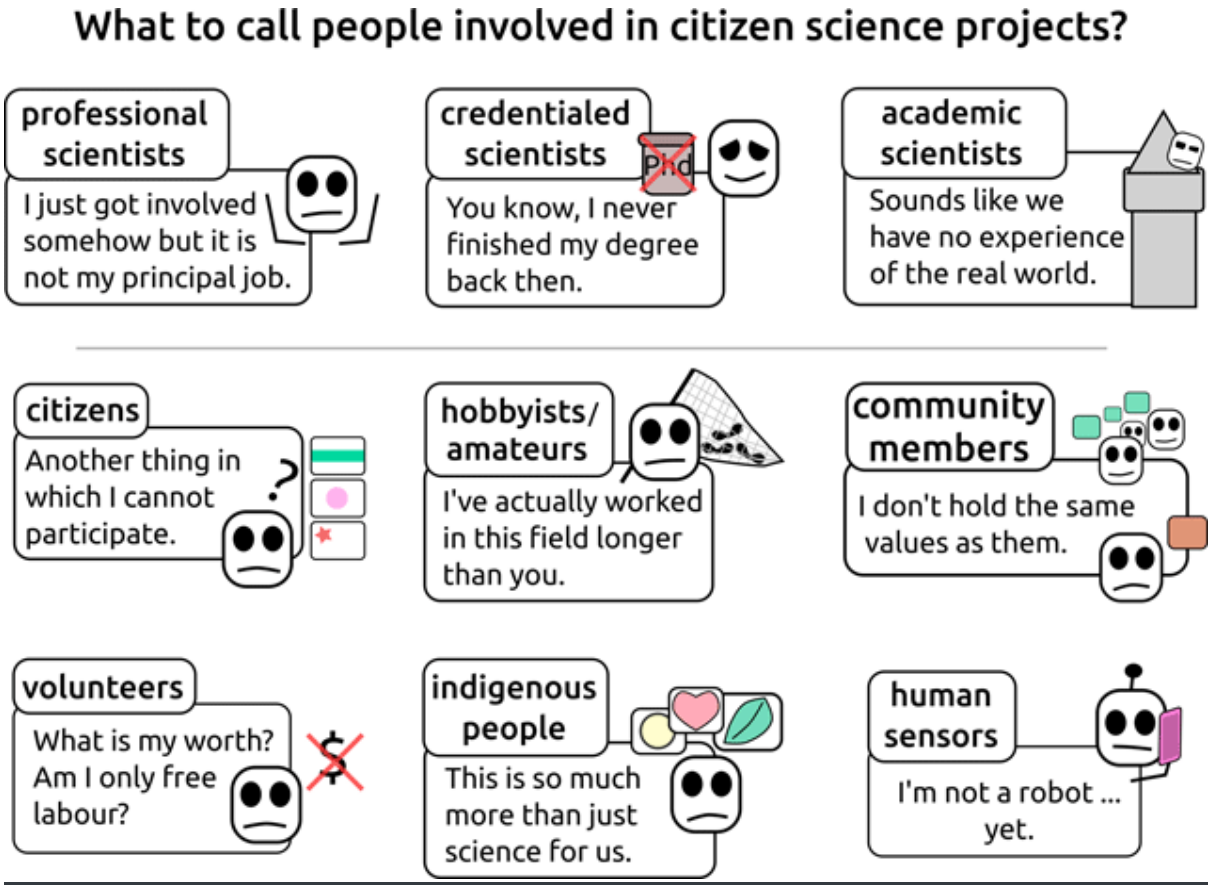


Figure by Eitzel et al. (2017) on http://doi.org/10.5334/cstp.96 (CC-BY 4.0)

The next slide provides a transcript of the text in the image for those using a screen reader.

Slide 7 - Citizen scientist, volunteers…? (2)

Title of the image: "What to call people involved in citizen science projects?"
(The term, its negative interpretation and a description of an image accompanying it are provided.)

- Professional scientists: I just got involved somehow but it is not my principal job. Person with hands in the air.
- Credentialed scientists: You know, I never finished my degree back then. Person next to a crossed out paper symbolising a PhD.
- Academic scientists: Sounds like we have no experience of the real world. Person in a tower (of Babel).
- Citizens: Another thing in which I cannot participate. Person next to three images representing country flags.
- Hobbyists/amateurs: I've actually worked in this field longer than you. Person next to a flag or map with footsteps.

- Community members: I don't hold the same values as them. Person with an orange square (representing their values) stands far away from three people all of them with green squares (representing the same values).
- Volunteers: What is my worth? Am I only free labour? Person next to a crossed out money symbol.
- Indigenous people: This is so much more than just science for us. Person next to three abstracts symbols of a sun, a heart, and a leaf.
- Human sensors: I'm not a robot… yet. Person with an antenna on their head holding a mobile phone/smartphone to their ear.

Slide 8 - Open Science (1)

Open science

One of the most discussed topics in research and innovation currently that intersects with citizen science is open science (OS). The OECD defines open science as "… efforts to make the output of publicly funded research more widely accessible in digital format to the scientific community, the business sector, or society more generally".

The six principles of open science are: open methodology, open source, open data, open access, open peer review, and open educational resources.

How do citizen science and open science intersect?

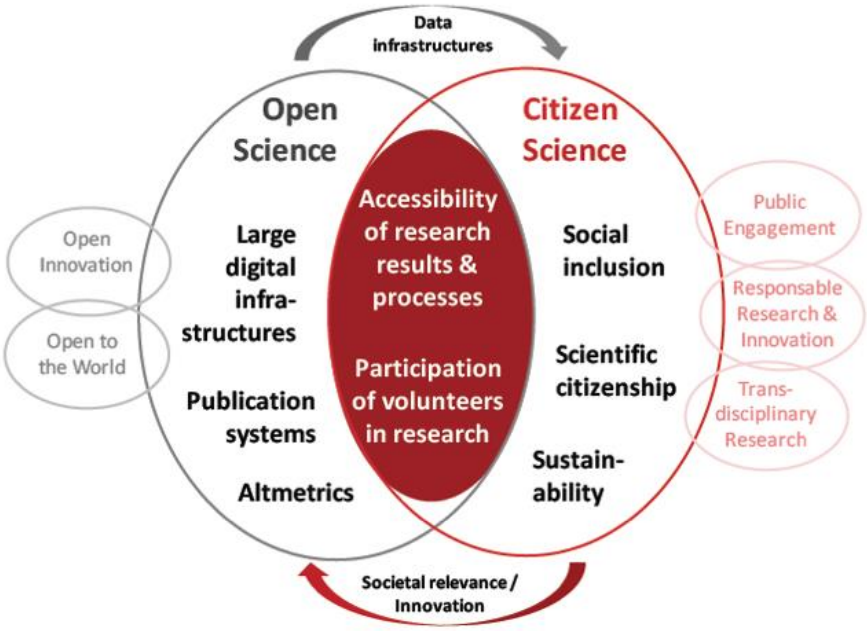


Diagram by Vohland and Göbel (2017) on https://doi.org/10.14512/tatup.26.1-2.18 (CC-BY 4.0)

Slide 9 - Open Science (2)

Citizen science enables openness by making project generated data available (principles of open data and open access) or by contributing to the development of freely (re)usable research tools and methods (open methodology and open source).

At the same time open science facilitates participation since participation in projects is encouraged and researchers are more accessible allowing a wider audience to suggest possible research topics. In addition, open science promotes citizen science by making existing data and literature behind a paywall accessible to citizens and promoting open source tools (hardware and software).

❖ Main terms of citizen science - Part B (8 minutes)

Slide 1 - Typologies of Citizen Science - Hacklay et al. (2018)

Typologies of citizen science

Citizen science is a very broad and diverse field with many different kinds of projects aiming to achieve a variety of goals. In the same way that there is a plethora of definitions of citizen science, there are at least 13 typologies of citizen science that try to make sense of the field, according to a review carried out in 2020. While no typology is perfect, it is useful to look at some of them.

In the following slides, three different typologies of citizen science will be introduced and linked to relevant terms in the field and to some examples.

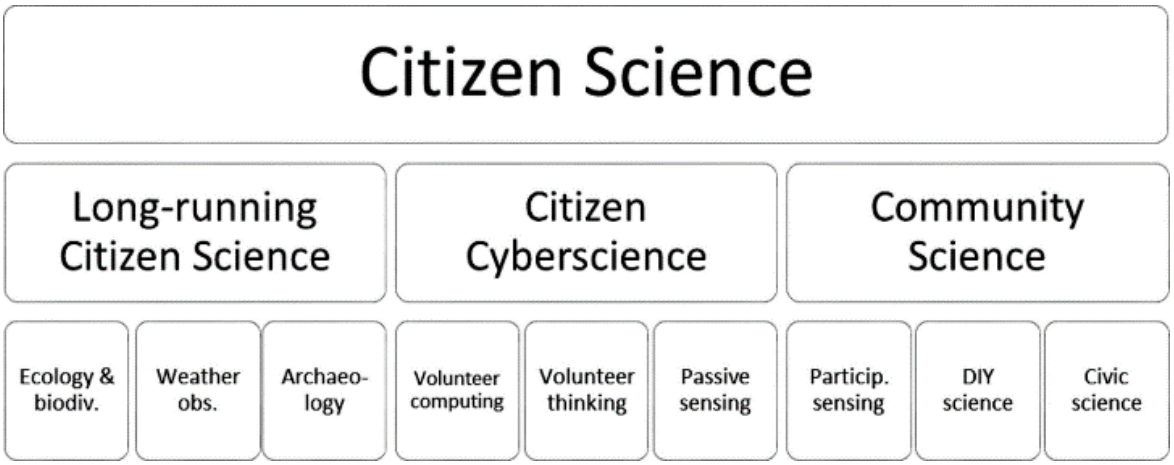


Diagram by Haklay, Mazumdar & Wardlaw (2018) on https://doi.org/10.1007/978-3-319-65633-5_4 (CC-BY 4.0)

The first typology was developed by Muki Haklay, Suvodeep Mazumdar and Jessica Wardlaw in 2018. It looks at major types of activities and projects in citizen science and classifies them by their domain, technical needs and level of engagement of participants.

Slide 2 - Long-running Citizen Science

Within **long-running citizen science** fall activities that are well established and that have been going on for a long time. An example of this are ecological observations (also called biological observations in the UK), where people report seeing plants, animals, and fungi. There are many projects of this kind, e.g. bird-watching projects where observations are reported.

Another example is meteorology or weather observation. Several examples of this were introduced in the last section; remember the nearly 13 million monthly observations that the UK meteorological office collects on its Weather Observations Website (WOW), or the Irish man who received an award for measuring rainfall daily for 56 years – that is long running!

(Photo by WMO)

Slide 3 - Citizen Cyberscience

The next group of activities or projects relies highly on technology and so are called Citizen Cyberscience – a term that Francois Gray coined in 2009. **Citizen Cyberscience** is defined as an activity that completely relies on the use of the internet and computing devices and that could not take place otherwise. These activities are separated into three kinds:

- **Volunteer computing** is a type of participation in a project by downloading software to your computer or smartphone, which allows it to use the devices' processing capacity when you are not using it.

- **Volunteer thinking** is when people participate in a project that sends them information over the internet and asks them to classify or annotate it. For example, identifying animals in an image.

- **Passive sensing** is mostly based on automatic data capture and sharing without the conscious intervention of the volunteer, who simply connects a sensor to their computer or smartphone or uses a built-in sensor, e.g. the integrated movement sensors to enhance observations from existing seismic observation stations.

Screenshot of the Quake-Catcher Network at: https://quakecatcher.net/join/

Slide 4 - Community Science

The last group of projects are those where participants have a wider role in shaping the project, **community science** projects, as described in part A of this section, in which participants are more involved in the project design, analysis and interpretation.

- In **participatory sensing**, the participants in the project have a role to play in deciding where the sensing takes place. In these activities, a group of participants contributes together to a body of information. Importantly, the term is now used to describe a wide range of crowdsourced sensing activities with varying levels of engagement.

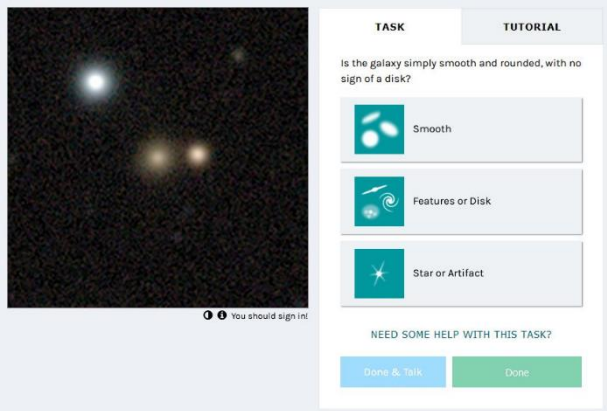
- **DIY science** projects are those in which people are using Do It Yourself (DIY) techniques and approaches to address issues that concern them, either in their environment or in a laboratory. Within DIY science fall also projects in which people are exploring aspects of modern biology through an exploration of what they can do with DNA analysis and other sequencing activities – this is called **DIY Bio** or sometimes also **Biohacking**.

- Another area of DIY science is called **civic science**, when the activities are explicitly linked to community goals and question the state of things. While some DIY science also follows this definition, civic science can also include work with indigenous, non-literate communities using smartphones to record community resources and other local features.

Slide 5 - 5 Cs typology (1)

The second typology that we will briefly look at was developed by Jennifer Shirk and her colleagues in 2012. Here, citizen science projects are divided into categories depending on the degree of participation, focusing on the role of project designers and owners. This typology focuses on projects within the field of ecology and environmental conservation and management. It can be called "5 Cs" typology as projects are classified into five categories, all starting with "C":

- **Contractual** – communities ask professional researchers to conduct a specific scientific investigation and report on the results, e.g. on possible pollution being emitted from a local power plant;
- **Contributory** – generally designed by scientists and for which members of the public primarily contribute data, e.g. the micro-tasks in Galaxy Zoo where there was also basic analysis;



Screenshort of the Galaxy Zoo project website

- **Collaborative** – generally designed by scientists and for which members of the public contribute data but also help to refine project design, analyse data, and/or disseminate findings;

Slide 6 - 5 Cs typology (2)

- **Co-Created** – designed by scientists and members of the public working together and for which at least some of the public participants are actively involved in most or all aspects of the research process; and

- **Collegial** – non-credentialed individuals conduct research independently with varying degrees of expected recognition by institutionalized science and/or professionals.

Contrary to the typology just seen at the beginning, this one ignores the domain and technology that is used, a major benefit since the degree of participation can be quantified and

compared. Notice that most citizen science projects are contributory, so one class is actually capturing most of the activities.

Slide 7 - Haklay's Typology (1)

The last typology that we will look at is Muki Haklay's typology developed in 2013, which is written from the perspective of participatory action research as well as aspects of geographical crowdsourcing (known as *volunteered geographic information*, VGI). Its aim is to explain different levels of participation in citizen science projects.

This typology is influenced by Arnstein's ladder of participation – created in 1969 by Sherry Arnstein in the context of citizen involvement in planning processes in the US, which is strongly value-based and aims to encourage citizen control over decision-making.
Haklay's typology includes four levels as follows:

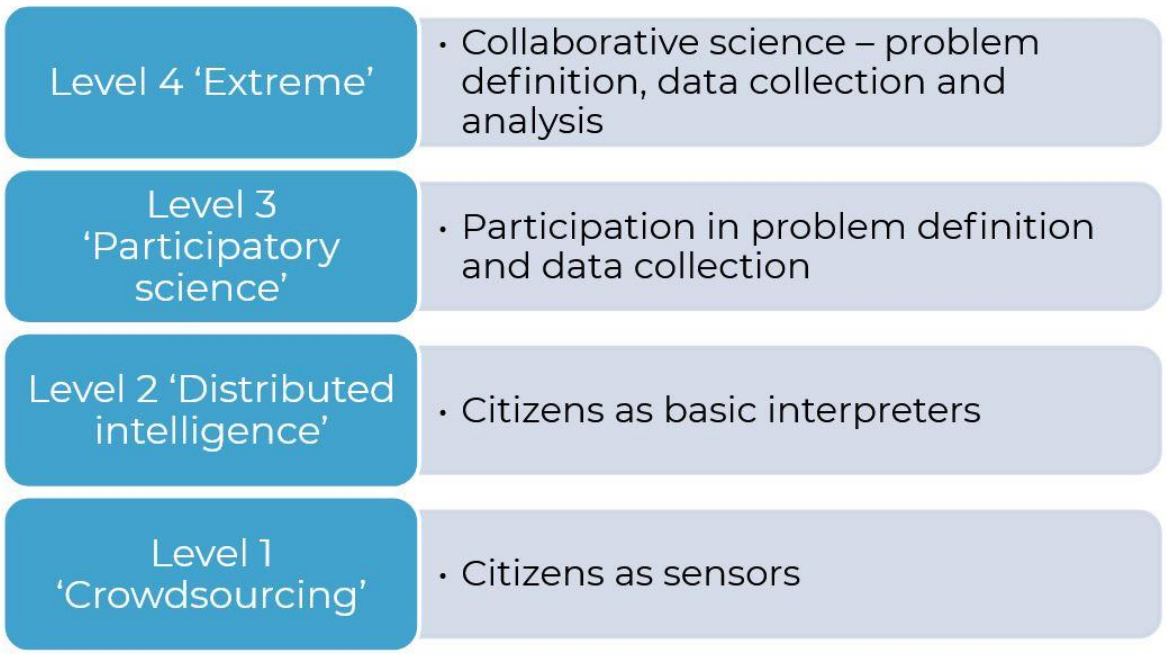


Diagram by Haklay (2013) on the training module on "Citizen Science Typologies" on the EU-Citizen.Science Moodle (CC-BY 4.0)

Slide 8 - Haklay's Typology (2)

The **crowdsourcing** level is mostly aimed at the provision of resources specific to an activity, which encompasses providing computing resources or the ability to sense different areas and it includes **volunteered computing** and **passive sensing** that we have seen in this section. Most of these projects are contributory. A good example of this level is "Quake catcher" where people are joining with their computer to create a small graphic network and the computer is doing that while they are doing other activities that we have seen a few slides back.

Distributed intelligence is a level that uses the cognitive abilities of the participants, either in micro-tasks such as in the Galaxy Zoo project or through basic observations as is done in different ecological projects. Participants require more training to ensure that the appropriate data collection or analysis has been carried out. These are contributory projects.

Participatory science are projects in which participants are involved in problem definition and in data collection although the experts are involved in the design and in the analysis of the data. Participatory science projects are part of co-created projects. Community noise data collection is a good example of that where the community takes noise meters and uses them under the guidance of a scientist.

Slide 9 - Haklay's Typology (3)

The final level is **extreme citizen science** where participants are involved in the project by setting the project goal and carrying out the data collection, analysis and action. Professional scientists – if they are involved – act as facilitators. These projects are equivalent to Shirk and colleagues' collegial project. The work of the Public Lab and the Louisiana Bucket Brigade is an example of this type of activity; they identified the problem, decided on the tools to carry out the analysis, and used the results. Notice that earlier we have associated the same activity with community science. This is common in this area and different terms are used to describe an activity – it depends on what we want to emphasise.

Balloon Mapping (Photo by Public Lab CC-By)

The issue with this typology is that, compared to the typology of Jennifer Shirk and colleagues, it does not include collaborative projects where there is refinement activity by the participant. Also, although contributory projects are now better represented, the typology still includes virtual projects and field observation in the same category – that is something that other typologies have done better. Then, there is the issue with drawing on the Arnstein ladder, which might be misinterpreted as value judgment that suggests that extreme citizen science projects are more valuable than a crowdsourcing project, which was neither the intention nor is this the case.

❖ Further terminology to expand your knowledge (optional - 10 minutes)

In this list you will find more terms for reference that you may find when reading about citizen science. While we do not deem the following terms essential in an introductory training unit on

citizen science (hence why this section is optional), they can broaden your understanding of the field. This list in the form of an accordion allows you to click and choose what you would like to expand on.

- **Citizen observatories**

"Citizen Observatories (COs) are community-based environmental monitoring and information systems that invite individuals to share observations, typically via mobile phone or the web." (WeObserve)

There are several definitions of citizen observatories. Common to these definitions are that i) citizens participate in environmental monitoring and governance, ii) citizen-generated in-situ observations can strengthen environmental monitoring capabilities, and iii) citizens use their own devices such as smartphones, tablets, laptops or other modern web technologies to generate these observations.

Sources and further links:

- https://www.weobserve.eu/about/citizen-observatories/
- The EU-funded WeObserve project ran from December 2017 to March 2021. It tackled three key challenges that Citizens Observatories (COs) face: awareness, acceptability and sustainability. The project aims to improve the coordination between existing Citizen Observatories and related regional, European and International activities. The WeObserve mission was to create a sustainable ecosystem of Citizen Observatories that can systematically address these identified challenges and help to move citizen science into the mainstream.
- Ground Truth 2.0 was a 3-year EU funded project that set up and validated six citizen observatories in real conditions, in four European and two African demonstration cases. The project demonstrated that such observatories are technologically feasible, can be implemented sustainably and that they have many societal and economic benefits. The ultimate objective was the global market uptake of the concept and the enabling technologies.
- The Ground Truth 2.0 website provides an overview of six Citizen Observatories in Zambia, Kenya, Sweden, Spain, The Netherlands, and Belgium.

- **BioBlitz**

BioBlitz is composed of 'bio' meaning life and 'blitz' which means quick and intensive. In a BioBlitz event members of the public, scientists, students, and naturalists work together to create a snapshot of the variety of life that can be found in a delimited area (urban or rural) trying to record as many species of plants, animals and fungi as possible over a defined period of time (usually 24 hours).

A BioBlitz provides the public with the opportunity to contribute to a scientific survey at the same time that it breaks down barriers to engagement with science and raises awareness of the role of biological recording. The results of a BioBlitz are datasets able to complement long-

term inventories and contribute to reporting progress towards national targets as well as informing decision-making processes.

The term ‘BioBlitz’ has developed international recognition in the media as an exciting and fun way to get the public to explore natural spaces and discover wildlife.

Sources and further links:

- DITOs consortium, (2017). BioBlitz: Promoting cross border Research and col-laborative Practices for Biodiversity Conservation. DITOs policy brief 1. Available at: https://discovery.ucl.ac.uk/id/eprint/1573359/
- Robinson, L.D., Tweddle, J.C., Postles, M.C., West, S.E., & Sewell, J. (2013) Guide to running a BioBlitz. Natural History Museum, Bristol Natural History Consortium, Stockholm Environment Institute York and Marine Biological Association. Available at (direct download): https://www.nhm.ac.uk/content/dam/nhmwww/take-part/Citizenscience/bioblitz-guide.pdf
- National Geographic has a page called “BioBlitz and iNaturalist. Counting Species Through Citizen Science“ available at: https://www.nationalgeographic.org/projects/bioblitz/

- **Citizen Social Science**

“Citizen social science is the term most commonly associated with a form of citizen science in the social sciences or alternatively one that has a specific focus on the social aspects of citizen science. It can involve citizens in the design and/or conduct of social research, including engagement in some or all research processes, such as ideation, research design, data collection, analysis, dissemination, and impact.”

Citizen social science draws on the tradition of participatory approaches both in participatory action research (PAR) and the co-production of knowledge, and uses tools and concepts that convey scientific rigour and inclusion. Because citizen social science situates social concerns at the centre of research, it gives voice to under-represented or vulnerable groups and can thus contribute to raising social concerns and to the inclusion and representation of underserved communities in the public sphere.

Source:

- Albert A., Balázs B., Butkevičienė E., Mayer K., Perelló J. (2021) Citizen Social Science: New and Established Approaches to Participation in Social Research. In: Vohland K. et al. (eds) The Science of Citizen Science. Springer, Cham. https://doi.org/10.1007/978-3-030-58278-4_7

- **Co-creation, co-design, co-production**

The terms co-creation, co-design, and co-production as used in the field of citizen science describe the collaborative work of professional scientists and citizens in the development and implementation of scientific projects.

Link:

- Service design tools website with a collection of tools, resources and materials: https://servicedesigntools.org/tools

- **FabLabs/Makerspaces**

The term FabLab comes from fabrication laboratory and refers to small-scale open workshops that offer digital fabrication. Sometimes they are referred to as MakerSpaces.

"A fab lab is typically equipped with an array of flexible computer-controlled tools that cover several different length scales and various materials […]. This includes technology-enabled products generally perceived as limited to mass production.
While fab labs have yet to compete with mass production and its associated economies of scale in fabricating widely distributed products, they have already shown the potential to empower individuals to create smart devices for themselves. These devices can be tailored to local or personal needs in ways that are not practical or economical using mass production.

The fab lab movement is closely aligned with the DIY movement, open-source hardware, maker culture, and the free and open-source movement, and shares philosophy as well as technology with them." (Wikipedia)

Sources and further links:

- https://en.wikipedia.org/wiki/Fab_lab
- The community maintains a list of all official FabLabs worldwide that was maintained by MIT until 2014 and is available at: https://fablabs.io/

- **Science shops**

"Science Shops are not 'shops' in the traditional sense of the word. They are small entities that carry out scientific research in a wide range of disciplines – usually free of charge and – on behalf of citizens and local civil society. The fact that Science Shops respond to civil society's needs for expertise and knowledge is a key element that distinguishes them from other knowledge transfer mechanisms.
A Science Shop provides independent, participatory research support in response to concerns experienced by civil society." (Living Knowledge Network)

Sources and further links:

- https://www.livingknowledge.org/science-shops/about-science-shops/
- Living Knowledge is the international Science Shop network and its webpage contains all about science shops. Here are some links.
- History of Science Shops: https://www.livingknowledge.org/science-shops/about-science-shops/history-of-science-shops/
- FAQ: https://www.livingknowledge.org/science-shops/faq/
- Living Knowledge Toolbox to empower new Science Shops: https://www.livingknowledge.org/resources/toolbox/

- **Living labs**

"A living lab (LL), in contrast to a traditional laboratory, operates in a real-life context with a user-centric approach. The physical and/or organisational boundaries of a living lab are defined by purpose, scope, and context. The scope, aims, objectives, duration, actor involvement, degree of participation, and boundaries of a living laboratory are open for definition by its participants. A living laboratory could thus be established on a street, in a house, within an organization, or include a whole city or industry, depending on the project.

The notion of living laboratory was first proposed by Prof. William Mitchell at MIT Media Lab as: 'a research methodology for sensing, prototyping, validating and refining complex solutions in multiple and evolving real-life contexts.'

However, contemporary definitions of living laboratories are broader and somewhat diffuse. Nevertheless, the following elements tend to be core features of a living laboratory:

- ➢ Experimental approaches in real-life context
- ➢ Participation and user involvement
- ➢ Collaboration and co-production of knowledge"

Source:

- http://fissacproject.eu/en/living-labs/

- **Participatory action research (PAR) and Participatory Health Research (PHR)**

"**Participatory action research** (PAR) is an approach to action research emphasizing participation and action by members of communities affected by that research. It seeks to understand the world by trying to change it, collaboratively and following reflection. PAR emphasizes collective inquiry and experimentation grounded in experience and social history. […] PAR contrasts with mainstream research methods, which emphasize controlled experimentation, statistical analysis, and reproducibility of findings. PAR practitioners make a concerted effort to integrate three basic aspects of their work: participation (life in society and democracy), action (engagement with experience and history), and research (soundness in thought and the growth of knowledge)."

Source:

- https://en.wikipedia.org/wiki/Participatory_action_research

"**Participatory Health Research** is a research approach. The goal of PHR is maximum participation in the entire research process for the people whose lives or work are being researched. The research process is designed as a partnership between all stakeholders, which include academics; health, social work, and education professionals; decision makers; and engaged citizens from civil society. Through participatory health research, new knowledge can be gained that will help promote health in society. All participants in the research are involved in the entire research process. They participate in formulating the research questions and goals; they jointly develop a research design; and they agree on the research methods, how the research should be evaluated, and how the results should be disseminated."

Source:

- http://partkommplus.de/1/forschung/participatory-research/

- **Community-based Participatory Research (CBPR)**

"Community-based participatory research (CBPR) is an approach to research that involves collective, reflective and systematic inquiry in which researchers and community stakeholders engage as equal partners in all steps of the research process with the goals of educating, improving practice or bringing about social change. At its core, CBPR questions the power relationships that are inherently embedded in Western knowledge production, advocates for power to be shared between the researcher and the researched, acknowledges the legitimacy of experiential knowledge, and focuses on research aimed at improving situations and practices. This approach to research is recognized as particularly useful when working with populations that experience marginalization – as is the case for some Indigenous communities—because it supports the establishment of respectful relationships with these groups, and the sharing of control over individual and group health and social conditions."

Source:

- Tremblay, MC., Martin, D.H., McComber, A.M. et al. Understanding community-based participatory research through a social movement framework: a case study of the Kahnawake Schools Diabetes Prevention Project. BMC Public Health 18, 487 (2018). https://doi.org/10.1186/s12889-018-5412-y

- **Public Participation in Scientific Research (PPSR)**

The term Public Participation in Scientific Research (PPSR) has been used as an alternative term to citizen science. According to the CAISE report – a very important report that came from the Center for Advancement of Informal Science Education – examples of PPSR projects include citizen science, volunteer monitoring and participatory action research. In this report, PPSR projects were divided into three major categories depending on the degree of involvement of the public. These are:

- ➢ Contributory projects: designed by scientists; members of the public contribute data
- ➢ Collaborative projects: designed by scientists; members of the public contribute data and participate in refinement tasks
- ➢ Co-created projects: designed both by scientists and members of the public working together; some (at least) members of the public participate actively in most or all steps of the scientific process

The CAISE report laid the foundation for the typology developed by Jennifer Shirk and colleagues in 2012 that was presented in part B of this section, the "5 Cs" typology, by adding the categories "contractual" and "collegial".

Source:

- Bonney, R., Ballard, H., Jordan, R., McCallie, E., Phillips, T., Shirk, J., and Wilderman, C. C. 2009. Public Participation in Scientific Research: Defining the Field and

Assessing Ist Potential for Informal Science Education. A CAISE Inquiry Group Report. Washington, D.C.: Center for Advancement of Informal Science Education (CAISE). Available at: https://eric.ed.gov/?id=ED519688

- **Responsible Research and Innovation (RRI)**

"Responsible research and innovation is an approach that anticipates and assesses potential implications and societal expectations with regard to research and innovation, with the aim to foster the design of inclusive and sustainable research and innovation. Responsible Research and Innovation (RRI) implies that societal actors (researchers, citizens, policy makers, business, third sector organisations, etc.) work together during the whole research and innovation process in order to better align both the process and its outcomes with the values, needs and expectations of society.

In practice, RRI is implemented as a package that includes multi-actor and public engagement in research and innovation, enabling easier access to scientific results, the take up of gender and ethics in the research and innovation content and process, and formal and informal science education." (European Commission)

Sources and further links:

- https://ec.europa.eu/programmes/horizon2020/en/h2020-section/responsible-research-innovation
- DITOs consortium, (2019). Research insight on RRI indicators that reflect the practice of public engagement organisations. DITOs policy brief 3. Available at: https://discovery.ucl.ac.uk/id/eprint/10073925/
- RRI tools website: https://rri-tools.eu/

❖ Summary (2 minutes)

As illustrated in this section, there are many definitions of citizen science – since citizen science activities and practices are found in different scientific disciplines – and there are also some uncertainties about exactly what the terms that are being used mean in a specific context. Different terms serve different goals and are appropriate for different audiences; it is advisable to check what the people running and involved in a citizen science project exactly mean.

In this section, we have introduced terms such as crowdsourcing, volunteer computing, participatory sensing, and several terms using the word science: DIY science, community science, citizen cyberscience, and civic science.

There are many ways to refer to participants, from citizen scientists (often used) to volunteers or amateurs. In addition, depending on the level or degree of participation of participants in citizen science projects (or, in other words, on the relationship between scientists and participants), projects can be classified in one way or another. For this, we have looked at

different typologies and learned that, since most citizen science projects fall within “contributory projects”, a way of sub-categorising them makes sense.

We have also learned that typologies and classifications can overlap and the same activity can be called differently depending on what we want to emphasise. In addition, we have shortly introduced one of the most discussed topics in research and innovation, the wider concept of open science, and seen how it intersects with citizen science.

❖ Self assessment quiz part 1 (optional - 1 min)

Drag the concepts into the correct boxes:

typologies, citizen cyberscience, definitions, bird-watching projects, activity being performed, community science projects, degree or level of participation

There are several [ ] of the term citizen science, since examples of it are found in different scientific disciplines that interpret the term slightly differently. A universal definition of what is and is not citizen science proves very challenging. Citizen science activities can be classified in different ways, either looking at the type of [ ] or by focusing on the [ ] . When looking at three different [ ] to try to make sense of the field you have been presented with the following terms and explanations:

- Within long-running citizen science fall activities that have been going on for a long time such as weather observations or [ ]

- Activities in [ ] completely rely on the use of the internet and computing, while in [ ] participants are more involved in the project design, analysis and interpretation. The latter are carried out as part of local, everyday settings, to address local concerns and needs, often related to environmental injustices and public health issues.

Answers: 1. definitions; 2. activity being performed; 3. degree or level of participation; 4. typologies; 5. bird-watching projects; 6. citizen cyberscience; 7. community science

❖ Self assessment quiz part 2 (optional - 1 min)

Drag the concepts into the correct boxes.

are seen as sensors, contribute data, four, 5 Cs, co-created, crowdsourcing, extreme citizen science

- The “[ ]” typology classifies citizen science projects into five categories called: contractual, contributory, collaborative, [ ] and collegial. Contributory projects are generally designed by scientists and for which members of the public primarily [ ],

e.g. the micro-tasks in the Galaxy Zoo project. Most citizen science projects fall within this category.

- Haklay's typology includes [ ] levels of participation; level 1 is called [ ], in which citizens [ ]. However, this concept is also used in the context of citizen science to describe finding a way to engage a (very) large number of people in a project. Level 4 is called [ ], where participants are involved in the project by setting the project goal and carrying out the data collection, analysis and action.

Answers: 1. 5 Cs; 2. co-created; 3. contribute data; 4. four; 5. crowdsourcing; 6. are seen as sensors; 7. extreme citizen science

CHALLENGES AND OPPORTUNITIES IN CITIZEN SCIENCE (13.5 MINUTES)

❖ Introduction (1 minute)

In this section, you can learn about common issues that are likely to come up when you are reporting or researching citizen science. These are common issues that people ask themselves when they learn about citizen science for the first time - and sometimes well beyond the first time! The questions don't only come from members of the public, but also professionals such as scientists, public health officials, and people in politics and government. By introducing you to these concepts and the existing discussion points about them, you can be better prepared to ask questions in interviews or find additional material in academic publications and other sources.

Image by Pete Linforth from Pixabay

In this section, we will cover five points. We start with data quality and the ability of people who are not professional scientists to participate in scientific research. Next, we will discuss the issue of engagement with volunteers and how citizen science is different and similar to other cases of volunteering. The issue of motivations and especially the link to activism come up as a way to question the validity of the research; issues of the type of participants and the dimensions of equity diversity and inclusion (EDI); and finally, the claims and evidence for benefits such as science literacy, awareness to issues, improvement in skills.

We will provide a short introduction to each of these topics through a short interactive presentation, and then provide you with additional information that explores it in more detail.

- **Can non-professionals collect or analyse data as well as professionals? (2.5 minutes)**

Slide 1 - Introduction

Imagine yourself as a professional surveyor in the early 2000s. Your job is to map in detail roads and buildings for different civil engineering projects. You use equipment worth thousands of Euros - including Global Positioning System (GPS) equipment, laser distance equipment, and rugged field computers. You are told that within less than a decade, ordinary people, equipped with consumer GPS receivers and mobile phones will use them and their home computer to create an accurate map of the world.

Photo by Paul Brennan on Pixabay

One of your first reactions will be: no one without my training and equipment is able to create good quality maps. While you are right in terms of creating maps that are precise down to a millimetre. For many users of maps, an accuracy of several centimetres is good enough. In fact, the improved ability of positioning on mobile phones and availability of high-resolution satellite images enabled people with good knowledge of computing and motivation to create such a map within the OpenStreetMap project.

These crowdsourced maps are now used by Apple, Microsoft, and the World Bank. It is not surprising that many scientists feel the same about their area, and not noticing the societal changes that enable high-quality citizen science data.

Slide 2 – Concerns

The concern about data quality is understandable. It is common to assume that the people who design and collect scientific data are well-trained experts. It is expected that data collection is carried out only after careful experiment design, selection of locations for data collection, and is done with specialised and expensive equipment. Therefore, the idea that “anyone” can collect or analyse scientific data with their smartphones and produce high-quality data sounds counterintuitive.

Photo by John Getchel on Flickr CC BY-NC 2.0

Slide 3 - Evidence

As a result, the question “can volunteers collect data as good as professionals” is very common. There are well over 50 scientific studies that compare the performance of participants in citizen science projects to experts. These studies consistently show that when the process of data collection is designed specifically for a wider audience, high-quality data can be obtained through the effort of volunteers. This requires an approach to quality assurance and data collection that is different from the standard scientific processes, which might explain the concerns.

Photo by Ahmad Ardity on Pixabay

Put simply, scientists are not trained or familiar with how to design high-quality processes for a wide audience as this requires a very different way of thinking.

Slide 4 - Methods

For example, while it will be too costly to employ 30 scientists who will classify the same picture of million galaxies, such a method is very common in citizen science. The image is shown to different volunteers who are not in contact with one another. The agreement among multiple

observers increases the confidence in the classification. Other methods are used in citizen science to ensure high data quality, such as identifying more experienced and accurate volunteers and allocating to them the task of checking the data that was collected by less experienced participants.

Another method is to engage experts in verifying the observations that are marked as more uncertain.

Photo by Muki Haklay

❖ Additional information on data quality in citizen science (optional - 2 minutes)

- **Evidence for the ability of participants to collect high-quality data**

Multiple studies demonstrate the ability of volunteers to collect high-quality data. Below we provide some links to sources that are discussing how you can ensure high data quality within citizen science projects.

In the paper "Assessing data quality in citizen science", Margaret Kosmala and her colleagues explain the details of ensuring data quality in environmental projects. They explain how it is possible to design a project that will ensure that the quality of the data that is resulting from it is high.

Another useful source is Caren Cooper's blog post from 2016 on Quality and Quantity in Citizen Science. The post is explaining the reasons that we can trust citizen science data and some of the methods that are used to ensure it.

- **Evidence that the analysis by volunteers is leading to high-quality data**

There are also good theoretical reasons why the quality of analysis is high when the public is asked to analyse data, which is based on the multiple observers' concept that we presented above. In a paper by David Watson and Luciano Floridi on "Crowdsourced science: sociotechnical epistemology in the e-research paradigm", they explain that the difference of verification by multiple people is as important as expertise. In some cases, such as the classification of information, the crowdsourcing approach is superior to other methods that are used in science.

There are also studies that demonstrate the high quality of data - for example, in a 2010 study about how many volunteers can map an area well, Muki Haklay and his colleagues show that when you have multiple people working at the same area in OpenStreetMap, the quality of the data does go up.

- **The challenges of governmental organisations in integrating citizen science data**

Government organisations, due to their hierarchical and command & control structures, can find it challenging to integrate citizen science and crowdsourcing projects. A good study by Daren Brabham from 2013 explains these challenges and offers a process for integration. Another study, by the World Bank, shows that government bodies can work in collaboration with non-governmental organisations to integrate such processes in their work.

❖ Why do people participate in citizen science? (3 minutes)

Slide 1 - Why people participate

Why do people participate in citizen science? This is a very common question. The question can come up for different reasons. For example, a scientist might want to know what will be the right way to recruit people to join her project, or a government official may wonder if it is
appropriate to invest in a citizen science programme “if we build it, will they come?”. From time to time, there will be people who will approach this in an instrumental way that is at risk of becoming unethical exploitation of someone to get them to contribute an effort for free without any gain.

Other motivations, especially those that are linked to “activism”, are viewed with suspicion.

Photo by Nathan Lemon on Unsplash

Slide 2 - Research

As with data quality, it will come as no surprise that when scientists have such questions they set off to research them - even when they have little expertise in behaviour and psychology! There are hundreds of academic articles on the issue of motivation in citizen science, and some of them are telling us more about the way that scientists think about the public than explaining motivation. However, there is plenty of good research that is building on psychological and sociological research on volunteering.

Overall, the research shows a wide range of motivations.

Photo by Leon on Unsplash

Slide 3 - Motivation

Motivation is frequently seen as something that is inherently valuable personally (intrinsic motivation) or something that provides an external benefit - such as payment or a job (extrinsic motivation). In citizen science projects it is common to find motivations such as: contributing to science and taking part in scientific discovery. For example, you can help scientists through the identification of galaxies, and you are likely to be the first human that looked at a picture from a space telescope. Similarly, addressing a problem that someone dear to you suffered is a motivation for participation in drug discovery projects.

Many citizen science projects also add a game-like element (gamification) and this can encourage people to record more observations to achieve a goal - e.g. getting to 100 pictures during a weekend. However, gamification can lead to unwanted incentives and reduce the quality of the data. Different projects and activities in citizen science are linked to different motivations, and there are no magic levers that will always work.

Slide 4 - Activism

Activism is the type of motivation that has received special attention. Activism in citizen science is frequently linked to environmental issues. We've seen it in the story about the Louisiana Bucket Brigade, with the community collecting evidence of air pollution incidents. The suspicion towards activism is the result of scientists and officials believing that professional standards and ethos mean that scientific data collection is objective activity. Therefore, activism might lead to bias in the data collection process, so it supports the goal of the activists.

"Bucket Brigade" (Photo by Sarah Craig/Faces of Fracking on Flickr CC)

The way this challenge is addressed is by paying special attention to data quality and verification in such projects. The Louisiana community was sending its samples to an accredited laboratory that is recognised by the Environment Protection Agency, and this way they could demonstrate an unbiased data analysis.

Slide 5 - Payment

Finally, an important aspect of participation is the idea that participants in citizen science projects are volunteers. We have seen that some definitions of citizen science explicitly mention volunteers. An indirect assumption here is that volunteering differentiates the lay participant from the research assistants who get paid for their effort to assist the scientists. While this is generally the case, this is not universally true. In some cases, especially when a project includes the participation of a disadvantaged group, some financial compensation for the time that is dedicated to the project can be in place.

Photo by Steve Buissinne on Pixabay

❖ Who participates in citizen science and who is missing? (3 minutes)

Slide 1

We answered “why do people participate in citizen science?”, so let’s turn to who participates. Understanding who are the typical participants of citizen science projects is important to the understanding of issues such as diversity and inclusiveness, and, as we will see, also helps in answering how come the data quality is high.

Citizen science is a diverse practice that ranges from projects that are run by a single individual who quantifies their health to projects that reach out to millions of participants, so we can expect high variation in the answer to this question, but there are some common patterns.

Participating in the Christmas Bird Count (Photo by US Bureau of Land Management CC PDM 1.0)

Slide 2

Let’s first look at how many people participate in citizen science. Currently, the numbers are fairly small out of the total population. For example, in the United Kingdom (UK), every January, the Royal Society for the Protection of Birds runs the “Big Garden Birdwatch” which asks people to identify and report the birds that they see in their gardens for one hour. This is the largest wildlife survey in the world and engaged one million people in 2021. This was a peak year, due to the pandemic lockdown. Even so, they represent 1.5% of the total population.

When it comes to projects that require more time involvement, the percentage of participation is much smaller. For example, we can estimate that only 0.1% of the population in the UK regularly contribute to online and offline projects, such as Galaxy Zoo or the weather observations that we mention in our introduction. This is why there is an interest in sharing information about citizen science and welcoming more people — there is plenty of scope for more people to join.

Slide 3

When we look at the profile of the people that participate in different citizen science activities, we can consider a range of characteristics — age, gender, nationality, and so on. One of the interesting aspects is the level of education. For example, while the general level of education across advanced economies in Europe is that about a third of the population attended higher education. Even in the highest attainment countries in Europe like the UK or Luxembourg, only about 45% of the population reached this level.

However, in Galaxy Zoo, 65% of participants had tertiary education and 10% had doctoral-level degrees. In the OpenStreetMap project, 78% of participants hold tertiary education, with 8% holding doctoral-level degrees. Across many projects, people who went to university are overrepresented. This can explain the quality of the data — since such participants understand the requirements of scientific research.

Photo by McElspeth on Pixabay

Slide 4

Many projects show a gender bias, but the picture indicates that differences in project design and management can lead to different outcomes. For example, in the OpenStreetMap project surveys show over 95% male participation, while in Transcribe Bentham, a project in which volunteers participate in transcribing the writing of the English philosopher Jeremy Bentham, nearly two thirds of participants are female. In a study in the UK in 2015 of participation in environmental citizen science, there was close participation between male and female. Studies also show higher participation of people over the age of 40s, and white.

It is, therefore, not inaccurate to assume that a typical citizen science participant is a male, with a university education, white, and middle-aged. They are also likely to know English, which is the language that is used widely in science. Yet, care should be taken about a specific project — it is a good idea to ask the project coordinators about their effort to be inclusive and what is the profile of the participants.

❖ What are the benefits of citizen science? (3 minutes)

Slide 1

Finally, let's turn to the benefits. What do the participants get out of participating in citizen science? As we've seen in the examples throughout this unit, scientists are getting many benefits: data from places that they can't reach; volunteer effort in collecting and analysing data; and access to resources such as a weather station at someone's home. But what evidence do we have that the people who join such projects also benefit?

Here we will look at some of these paybacks. They include multiple aspects, ranging from learning a topic to understanding much more how scientific processes work, but also skills such as engagement with others and even health benefits.

Slide 2

Citizen science has a role at different levels of education. At school, even at a very early age, citizen science provides an opportunity to learn that science is not a solid and unchanged body of knowledge but a process of exploring and understanding the world. For example, children aged 8-10 in Blackawton school in the UK co-design and carried out an experiment that demonstrated that bees can differentiate colour patterns. This is also true for students at universities. Usually, they have little opportunity to participate in active research projects during their undergraduate studies.

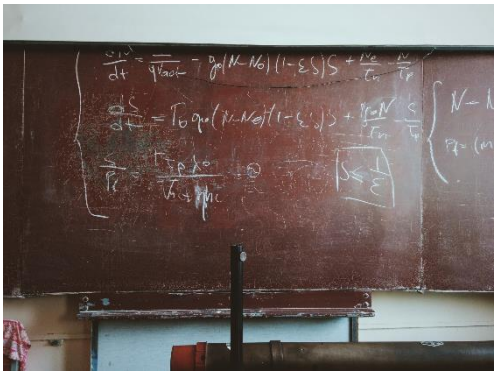


Photo by Roman Mager on Unsplash

Citizen science also contributes to learning out of school or college, in what is called “informal learning”. This is because it allows people to engage with a scientific issue and learn about it in the outdoors or during a visit to a museum.

Slide 3

Another area where participation in citizen science can provide benefits to the participants is through creativity and innovation. This is especially true with the area of Do-It-Yourself (DIY) science. The development of new measurement instruments or new sensing techniques is an integral part of DIY science. Organisations such as Public Lab, which was mentioned in the balloon mapping case, encourage the people who use the instruments to adjust the blueprints and share the results with other participants.

Photo by Public Lab CC By 2.0

Such online communities have led to the creation of new instruments that can be used for different purposes.

Slide 4

There are also valuable skills that are relevant not only within scientific projects but for other areas in life. For example, we mentioned that in Galaxy Zoo, some participants volunteered to assist with managing the online forum. This provided an opportunity to learn about online community management, keeping the conversation flowing and civilised and so on.

Monarch tagging (Photo by Katja Schultz on Flickr CC By 2.0)

Another life skill that citizen science can provide is in managing records of observations and information that was collected and uploading them to shared information systems.

Finally, there are also opportunities to develop writing skills — from sharing results on a blog or social media, and potentially learning how to write a scientific paper.

Slide 5

In the projects that are led by communities, such as recording the level of noise in their area or air pollution, the participants gain the ability to provide evidence for the harm that they are experiencing. While these projects are not always leading to a solution to the environmental issues that sparked them, the ability to collect and share the information that demonstrates the issue is valuable by itself.

Analysing the results of community air quality mapping (Photo by Muki Haklay CC By 4.0)

❖ Summary (1 minute)

In this section, we have answered a set of questions about citizen science, which are frequently coming up. The questions were — How can volunteers produce high-quality data? Why do people participate in citizen science? Who participates in citizen science? And What do they get in return for their effort? These questions are, of course, linked. We can now see that because people are motivated to help a scientific effort and are frequently holding higher education,

they pay attention to how they collect data. This, in turn, explains the high quality of the resulting data.

These questions are important for different citizen science projects, and within each project, the answers will be different. There can be citizen science projects that are aimed at recruiting volunteers with special expertise — in the same way that Doctors without Borders seek out volunteers who are medical experts. In such cases, the answers to questions about inclusiveness and diversity will be limited to the pool of available participants and structural inequalities might mean skewed participation. This should not lead to an immediate critique of the project — it needs to be examined holistically, including the benefits from the project to the wider population.

❖ Self assessment quiz - select the right option (optional - 2 minutes)

Question 1

Online citizen science can use the decisions of multiple participants as a way to ensure high quality of data

- Yes, this is correct; by evaluating the degree of agreement among the people that analyse the data, it is possible to reach high quality data
- No, this is not enough and there is a need that professional researchers test the information and the decisions of participants

***Answer*:** Yes, this is correct; by evaluating the degree of agreement among the people that analyse the data, it is possible to reach high quality data.

Question 2

Is there evidence that the data quality from citizen science is good enough?

- There are over 50-60 scientific publications that compared professionals and amateurs in data collection, and they consistently show that with appropriate training and project design, the quality of the data can be very high
- It is not possible for people without scientific training to collect data that will be at the same quality as professional researchers

- Regardless of project design, citizen science data is always high-quality

***Answer*:** There are over 50-60 scientific publications that compared professionals and amateurs in data collection, and they consistently show that with appropriate training and project design, the quality of the data can be very high.

Question 3

People are participating in citizen science mostly for fun, and it is very important to keep them entertained

- While important, it is not the main reason people participate in citizen science. Most participants want to contribute to scientific research and are pleased when their contribution is leading to a scientific discovery
- The statement is correct, and it is more important to maintain enjoyment - even if the scientific results are not as good as expected
- As a result of this, gamification and the use of leader-boards and other competition is central to activities in citizen science

***Answer*:** While important, it is not the main reason people participate in citizen science. Most participants want to contribute to scientific research and are pleased when their contribution is leading to a scientific discovery.

Question 4

People always participate in citizen science for the financial returns

- This is incorrect. In most projects, the participants are volunteering in their free time and resources. In some cases, especially when the project is working with marginalised groups, there is a value in some payment for the participants, but if the payment is too high, they are research assistants and not volunteers
- This is a major motivation in citizen science, and the projects are using a lot of money to ensure that they can employ a lot of participants

***Answer*:** This is incorrect. In most projects, the participants are volunteering in their free time and resources. In some cases, especially when the project is working with marginalised groups, there is a value in some payment for the participants, but if the payment is too high, they are research assistants and not volunteers.

Question 5

All citizen science projects are representing society as a whole - you will find people from all backgrounds in all projects.

- Because citizen science is open to the whole public, it is expected that people from all walks of life will join
- Unfortunately, this is incorrect. Many projects do have different biases in terms of representation and just like with science in general, there is a need to reach out and include people who are under-represented

***Answer*:** Unfortunately, this is incorrect. Many projects do have different biases in terms of representation and just like with science in general, there is a need to reach out and include people who are under-represented.

SOCIAL, ECONOMIC AND POLITICAL IMPACTS (10 MINUTES)

❖ Introduction (1 minute)

Citizen science, as indicated in its name, is an activity that contributes to science in general. You have now discovered through the previous sections that it can be applied in every domain of science and throughout any step of the scientific process. This section will now provide you with an overview of the benefits that citizen science can bring to other aspects of society, besides the production of science.

With practical examples, we will go through different aspects of our society that can be impacted by citizen science projects or results.

First, of course, scientific studies can take a great benefit from citizen science to gather data or to conduct experiments. Also, society itself and local communities can find in citizen science a tool to improve citizen's lives. Then, interactions between citizen science and policy are mutual, as citizen science brings tools and pieces of evidence that policymakers can use in

their activities, and policies are crucial to support citizen science activities. Finally, we will explore together how citizen science raises awareness about environmental or global issues.

❖ Citizen science contributes to science (2 minutes)

In this section, you will discover the role that citizen science can have in the scientific research.

Slide 1

The core ambition of citizen science, like any branch of science, is to produce knowledge on the world around us. In particular, it is an amazing instrument to overcome barriers that scientific research faces, such as lack of time to analyse data or lack of resources to gather field data, to name a few.

Citizen science can be especially beneficial as it opens up the scientific process to the whole society and every actor can play a role and can help achieve these objectives.

Photo by Dieny Portinanni on Unsplash

Slide 2

When one thinks about the different types of impacts that emerge from citizen science, the first one that naturally comes to mind is data collection. Numerous apps or websites are offering a repository platform where citizen scientists can upload their discoveries or the data they have gathered.

The two following examples are both relying on online tools available at a large scale, but many smaller projects have also succeeded in producing high-quality scientific data in a more local setting, not always based on an online platform.

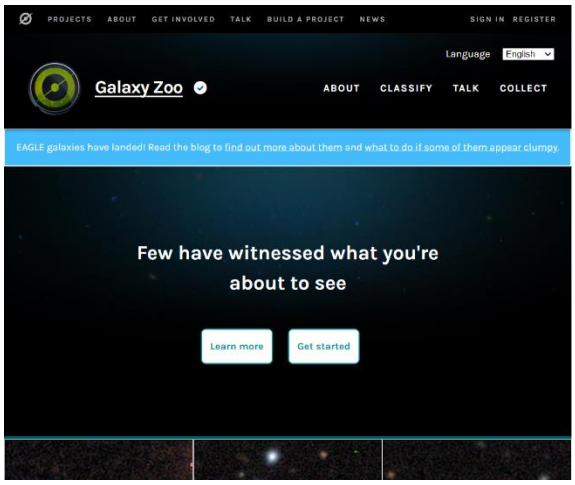
Photo by Ivie Metzen, NPS on Flickr

Slide 3

Booted Warbler (Photo by Elena-Votinceva on iNaturalist CC-By)

One of the most renowned apps is iNaturalist. In the mobile app, which is also accessible as a website, participants can upload pictures or videos of their natural observations and share them with the whole community. The data collected through this can then be used by various projects and is available to any scientist. The website is described as a "world-leading resource that combines observational data with artificial intelligence and community expertise to bring natural history into the digital age."

Slide 4



Screenshot of the Galaxy Zoo website

After biodiversity, the second scientific domain that is the most represented in citizen science is astronomy and space science, which has a huge potential for citizen participation due to wide public interest in astronomy. With the Galaxy Zoo project, which we came across earlier, participants can be involved in research by helping astronomers to explore the universe and identify particular objects.

Discoveries generated through this mean can have a great impact in the field, as happened with the "Green Peas" galaxies (a special class of galaxies) that have been identified for the first time by Galaxy Zoo participants.

Slide 5

There is a growing trend to give more credit to citizens who have participated and contributed to research in scientific publications. Indeed, for some projects, the majority of the data used for the research comes from citizen science and citizen contribution.

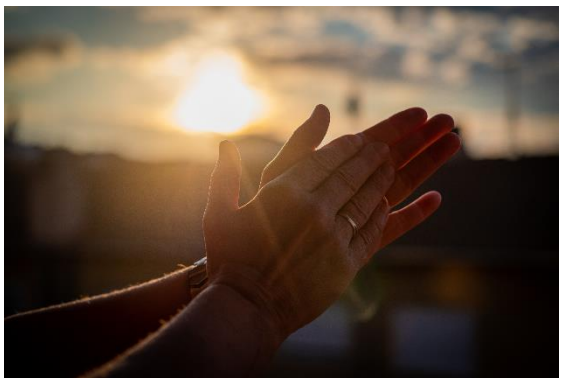


Photo by Guillermo Latorre on Unsplash

Despite that, the most eminent scientific publications do not integrate yet a possibility to credit other contributors than “official authors” of the study.

This issue is even more relevant when contributors are indigenous citizen scientists, who are already under-represented in science but take part in citizen science projects where they bring a huge contribution.

❖ Citizen science can impact society (2 minutes)

In this section, we will examine an example where a citizen science project and its results generated a deep change in the local life of inhabitants.

Slide 1

It would be rather reductive to consider citizen science only as a data production tool, that is solely beneficial to scientists. Citizen science is way more than this, and the interest of citizen scientists can not only be based on their motivation to help science but also on the benefits that they can personally or on a community scale, get from it. In history, citizen science has proven to have positive impacts in the localities where it is implemented, bringing a sense of community and offering an activity for the local participants but also through the scientific impacts generated.

Making sense logo

As an example of the societal impact, we will describe in detail a case that illustrates this point perfectly: the Making Sense pilot based in Barcelona.

Slide 2

Making Sense was a project that ran from 2015 to 2017 with the aim to engage communities around digital 'maker' culture, open design and environmental sensing.

One of their pilots was based in the Plaça del Sol in Barcelona. This neighbourhood was one of the noisiest of the city, due to the great number of bars and pubs localised in the area and its attractiveness to young people who used to regularly stay until late at night. This situation was no longer to the taste of the inhabitants, tired by these disturbances.

Banner "Stop the Noise" (Photo by Making Sense project)

Slide 3

With the help from the local Making Sense branch, the neighbourhood association has been researching and measuring the noise volume.

Concretely, they co-designed and built city sensors called ‘Noisebox’, based on a Smart Citizen Kit, that were able to monitor the noise level in the area. These sensors were placed on the balconies around the square.

Noisebox, displayed in the Plaça del Sol (Photo by Making Sense)

In order to raise awareness about this initiative, they have also developed a display to attract curious people with LED strips and a platform to allow visitors to express their feeling about the noise in the square.

Slide 4

Data gathered from this initiative supported the residents’ complaints: with peaks of more than 100 decibels in the middle of the night, the level was far higher than World Health Organization recommendations, causing severe disturbances and a possible impact on the inhabitants’ health.

Mapping the noise level in the neighbourhood of la Plaça del Sol (Photo by Making Sense)

With this information, the collective met the local policymakers and exposed the issue. Actions have been taken: the city council made some changes on the square itself, such as more police interventions to move people after a certain hour, or the addition of plant boxes on the steps where the groups were gathering.

In the end, this citizen science project has made a significant change in the neighbourhood and the life of the inhabitants has been truly improved.

❖ How citizen science influences policies (2 minutes)

This section will cover how citizen science projects can influence policy, at a local or at a larger scale.

Slide 1

The Making Sense provides a smooth transition to the next topic: the impact that citizen science can have on policies and governance.

Being a mix between evidence-based actions and citizen-led initiatives, citizen science has the potential to be of great interest to policymakers and public administrations.

The Making Sense example that we just covered is a good illustration of how citizen science initiatives can have a higher impact on policy decisions and how citizens, through citizen science, can make their voices heard in the governance of their localities.

Photo bv Laura Gil Martinez - IAEA on Flickr

Slide 2

Various local citizen science projects have been initiated by residents who were looking for a solution to a local problem and who needed concrete pieces of evidence to make their case to policymakers. The production of scientific data, especially coming from monitoring activities (either biodiversity, pollution etc), can inform policymakers of the current situation and help them develop policies in accordance with society's needs.

Water sampling (Photo by ACSA, species monitoring)

Slide 3

An example of a European-wide project is provided by WeCount.

WeCount sensor (Photo by WeCount project)

The EU-funded project WeCount enables citizens to initiate a policy-making process with fully automated measurement data in the field of mobility and air quality. Based on 5 different pilot projects spread out in Europe (Madrid & Barcelona, Leuven, Ljubljana, Dublin and Cardiff), citizens are invited to count and measure the traffic in their street and use this measurement data to contact the local or regional government in order to devise informed solutions to tackle various road transport challenges.

Slide 4

The 17 Sustainable Development Goals developed by the United Nations in 2017 are common goals that are shared by all member states to promote prosperity while protecting the planet.

In order to measure the progress towards their achievement, several indicators are monitored and followed closely by scientists and experts in every country. To do so, they need reliable and consistent data, and this is where citizen science can once again show its potential: It can provide a great source of data – if correctly coordinated and integrated.

The 17 Sustainable Development Goals (Project Everyone, CC-By-SA 3.0)

Slide 5

Analysis by Dilek Fraisl and her colleagues (2020) has shown that at the moment, citizen science is already contributing to the monitoring of 5 SDG indicators, and that it could

potentially contribute to 76 indicators. Added up, this could represent 33% of the overall number of indexes.

Citizen science could then be a great ally for the achievement of the SDGs, notably the goals linked to nature and environment and society:

- SDG 15 Life on Land
- SDG 11 Sustainable Cities and Communities
- SDG 3 Good Health and Wellbeing
- SDG 6 Clean Water and Sanitation

❖ Citizen science also raises awareness (2 minutes)

This section will cover a more horizontal outcome generated by citizen science: awareness-raising

Slide 1

If we go beyond the classification that we followed until now, which completely separates the three blocks “scientific”, “societal” and “political”, there is a last type of impact that has its roots in each of these categories: the educational impact, or the knowledge and skills that each type of participants can get from a citizen science project. These initiatives can raise awareness about specific challenges, can introduce participants to science in an accessible way and can empower them to choose science, either to solve local issues or even as a career path.

Photo by Denali National Park and Preserve on Flickr

Slide 2

Citizen science is also often used as a tool to reach out to communities that are not familiar with science. Many studies have shown that a significant proportion of the population doesn’t have access to what we call science literacy, due to social-economic reasons. Many citizen science projects have at heart to collaborate with these communities and are even specifically targeting them.

For example, the TROSA project in South Asia is based on voluntary engagement of local communities, mostly women and youth, to collect and analyze river water quality data to build an evidence base which subsequently informs multi-stakeholder dialogues for collective action on water governance.

Women collecting and analyzing river water quality data (Photo by asia.oxfam.org)

Slide 3

Several spaces can be used as a vector of science and citizen science projects.

First, schools. Formal education is the first means to teach scientific topics to children. Studies have shown that by being familiarised with science from an early age, children have a higher chance to overcome the glass ceiling that could prevent them from choosing scientific paths later in their studies. Citizen science adds the advantage to familiarise students directly with the scientific process, and to offer them a chance to experiment in a practical setting.

Photo by Australian Citizen Science Association - Seamus Doherty

Moreover, citizen science is a means to increase their awareness of societal problems such as air pollution, biodiversity monitoring etc.

Slide 4

Then, science museums. They are already recognised as a space for non-formal learning, and many of them are actually engaged in citizen science projects where their public can take an active part in the scientific research, more than being just passive visitors. For example, the Sparks project that took place from 2015 to 2018 designed a travelling exhibition called “Beyond the lab: the DIY science revolution” that was telling the stories of ‘DIY scientists’.

This exhibition travelled to different locations, always accompanied by a series of public events which related to local scientists and to the topics addressed by the exhibition.

The participatory activities organised were an invitation for the public to dive into the world of citizen science and discover that science was actually at their reach.

Sparks exhibition (Picture: © The Board of Trustees of the Science Museum)

❖ Summary (1 minute)

In this section, we discovered that the impacts resulting from citizen science projects go beyond the scientific field. Citizen science, more than being beneficial to scientific research, has also a positive impact on policymaking, on awareness-raising, and on society at large.

❖ Self assessment quiz (optional - 2 minutes)

In this quiz, you'll see four statements with multiple-choice questions. Try to identify the **correct** statements.

Question 1

What are the ESSENTIAL tools to contribute to scientific research through citizen science?

- Binoculars: no citizen science without going on a field-trip!
- None of the above: contributions to citizen science can have any format and every project will be different.
- A computer: the data collected will have to be uploaded to an online platform.

Answer: None of the above: contributions to citizen science can have any format and every project will be different.

Question 2

What has the Making sense pilot in Barcelona achieved? (Several answers possible)

- They have been successful in making the local policymaker make significant changes in the area to find a solution
- They have provided a noise-cancelling headset to each inhabitant.
- They have raised awareness about the local issue of noise disturbances

Answers:

- They have raised awareness about the local issue of noise disturbances
- They have been successful in making the local policymaker make significant changes in the area to find a solution & they have raised awareness about the local issue of noise disturbances

Question 3

The benefits brought by citizen science to policy are: (Several answers possible)

- Provide a guaranteed and constant a funding source
- Providing evidence-based arguments to solve society's problems
- Providing a reliable tool to measure the progress towards global objectives (with the SDGs for example)

Answers:

- Providing evidence-based arguments to solve society's problems
- Providing evidence-based arguments to solve society's problems & providing a reliable tool to measure the progress towards global objectives (with the SDGs for example)

Question 4

Besides scientific, societal and political impact, citizen science can: (Several answers possible)

- Empower local communities to take actions for problems that concerns them and that are often forgotten or ignored
- Be an occasion for organisations such as museums to interact in a different way with their visitors
- Raise awareness about science

Answer: All of them are correct.

CITIZEN SCIENCE IN THE NEWS (15 MINUTES)

❖ Introduction (1 minute)

Our final section is dedicated to ***Citizen Science in the news***. We have gathered here some interesting stories that we hope will enrich your ideas about how to integrate citizen science

stories into wider media topics. Such ideas can link to different aspects that are meaningful and interesting to diverse audiences. The stories selected are in English and cover a variety of topics and formats used. At the end of the section, you will find a selection of media citizen stories in several languages. We hope this will kindle your interest and provide you with useful ideas!

Photo by Good Good Good on Unsplash

The examples that we will see include: using citizen science as a vehicle for a major campaign of a newspaper in Belgium, and a way to engage the audience and promote the social engagement of the paper. The second example is for an environmental story on the decline in butterfly population, and the role of citizen science as something that the reader can do about it. The third story comes from a science report programme which reports on a citizen science project as a way to link to the audience at home.

❖ What happens when 20,000 Belgians turn into air pollution scientists? (5 minutes)

Curious noses (“Curieuze Neuzen” in Flemish) is a Belgian citizen science project that has been the biggest European citizen project tackling the problem of air pollution. "Curious noses" is an expression that also means "person who is interested" in Flemish, and this was clearly supported by the high number of adherents that the project had. Using low-cost and uncomplicated instruments, a tube and a cardboard sign, they gathered very valuable data that showed that living in big cities you are exposed to harmful particles. What makes this story a good one? The value of breathing clean air is shared by a large number of people, if not by everyone. Therefore, having a common value and concern, heightened the relevance of and interest in this project. Curious noses is now measuring the impact of dry seasons, especially drought, in their local environment and how this might affect inhabitants in the short term.

Screenshot of the home webpage of the Curious Noses.

Learn more about this story here:

- 3-minute video about Curious Noses: https://www.youtube.com/watch?v=oQwzB91llBI
- Curious noses in local media: https://www.vrt.be/vrtnws/nl/2021/01/21/curieuzeneuzen-in-de-tuin-nieuw-onderzoek-naar-droogte-in-tuine/ (or here as a pdf)
- Curious noses in specialised magazines:
  - ➢ https://meta.eeb.org/2018/10/04/five-things-we-learnt-when-20000-belgians-became-air-pollution-scientists/ (or here as a pdf)
  - ➢ https://www.nature.com/articles/d41586-018-07106-5 (or here as a pdf)
  - ➢ https://panoramatest.tbodev.de/en/solution/citizens-are-encouraged-be-nosy-about-air-quality (or here as a pdf)

❖ Where are you, butterflies? The Guardian covering the disappearance of butterflies (2 minutes)

The lessening of butterflies visiting fields and gardens has been widely documented. Due to pesticides, forest disappearance and industrial agriculture, they are not as common in the countryside. But what are the causes of its decrease in the city? It's the disappearance of butterfly-friendly habitats that appears to be the main cause and this is itself due to several factors and reasons. Some cities are embracing this cause and in a multi-actor coordinated action, they are putting in practice pollination plans. This story is good because it shows the capacity of coordinated communities, including the scientific and political communities, in reversing the pervasive effects of human development.

Learn more:

- Related content: Saving the monarchy butterfly and by doing so, the planet. 11-min video

https://www.ted.com/talks/mary_ellen_hannibal_how_you_can_help_save_the_monarch_butterfly_and_the_planet?language=en

- Building sites for butterflies downloadable PDF

https://butterfly-conservation.org/sites/default/files/2019-06/building_sites_for_butterflies.pdf

Flutter bye: where did all the city butterflies go?

A Small Tortoiseshell. Numbers of common British butterflies have fallen by 69% in cities and towns over the past two decades. Photograph: Cath Scott

Butterflies are vanishing from cities even faster than in the countryside – from paving, pesticides or just plain heat. But some cities are luring them back

Advertisement

Screenshot of the website, section cities, on The Guardian. (article as a PDF here)

❖ Scientific, useful and interesting enough for diverse publics? A BBC podcast showing the hooks of citizen science (3 minutes)

Let's see the case of this audio. This podcast was launched last year, as one of the episodes of the BBC series Inside Science. From around minute 14:45, the listener gets introduced to part of the history of citizen science such as radio-based research from the 1930s. This is followed by a discussion of the Zooniverse platform, which is 10 years old already. The reporter gets on the platform and describes his user experience, while he tells the audience he has chosen a project about penguins, helping scientists get more information about penguin populations. What makes this story interesting? In the episode, a person tries a tool live and tells the listener about his findings, curious facts and how his motivation rises because he is contributing to something he values.

Link to the podcast: https://www.bbc.co.uk/sounds/play/m000hpdl

Screenshot of the BBC website that showcases the podcast.

❖ Personal story that includes the use of citizen science as part of the personal achievement and a journey (2 minutes)

Citizen science can also feature in a discussion about community concern over a news issue. For example, the issue of local pollution from fracking activities for the extraction of gas and oil in the US gained attention in the early 2010s. This provided an opportunity for the US National Public Radio (Npr) to develop a story about the involvement of local people in monitoring the impact. Local reporter, Katie Colaneri, focuses her story on Joanne Martin, a resident of Pennsylvania, who has been carrying out water quality monitoring in the Brady Run stream for three years. The reporter uses her story to link the monitoring of environmental quality and the activism about the pollution that oil drilling can cause. In this case, the article focuses on the aspects of citizen science, but in other cases, the personal story takes centre stage.

Another example for such a story is the detailed profile of Hugh Brown and his effort to collect and monitor kissing bugs. The profile puts Hugh in the centre of the story, but also conveys the challenges of the Chagas disease and the wider context.

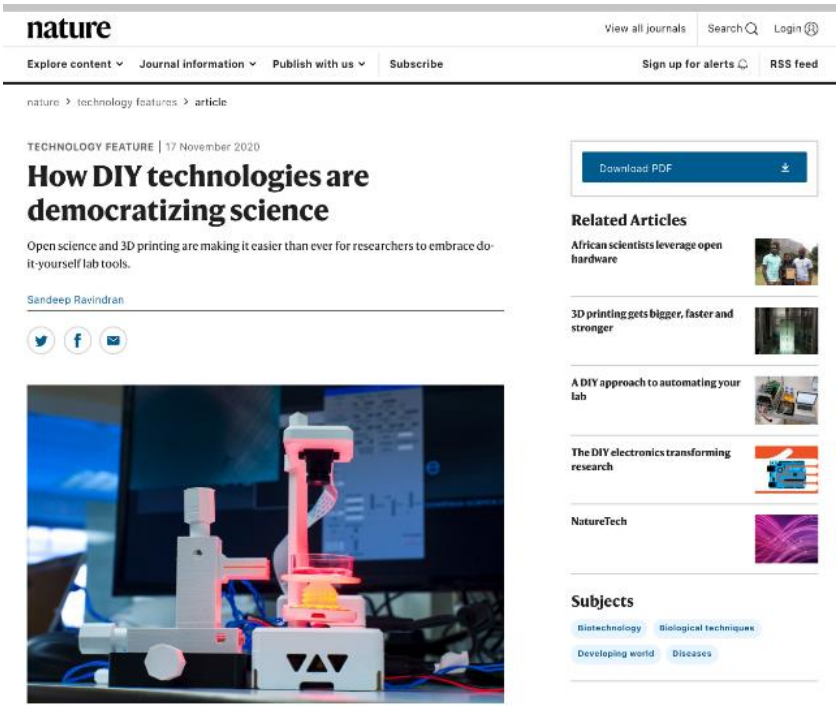
Source: https://www.statnews.com/2016/08/10/chagas-disease-kissing-bugs-hunt/ (or here as a PDF)

Screenshot of the State Impact website: https://stateimpact.npr.org/pennsylvania/2014/12/19/gas-drilling-draws-citizen-scientists-to-the-field/ (or here as a PDF)

❖ Stories about the technologies and innovation from citizen science (2 minutes)

The final example that we will use is about the technologies and innovation that are emerging from citizen science. When people get very involved in citizen science projects, a lot of the time they are experiencing limitations in their access to equipment. Since the need is the mother of invention, there is a range of examples of technologies that have been invented by participants. For example, in 2020, the high-level science journal Nature reported on the potential benefits of these Do-It-Yourself Science tools and how they can increase access to science. For example, a 3D printed microscope.

The story of novel ways of collecting and sharing data can also integrate into stories about a topic, or the achievement of a grassroots campaign, such as this example from the Guardian from 2014 about the use of DIY tools in measuring air quality.



Screenshot of the Nature magazine webpage: https://www.nature.com/articles/d41586-020-03193-5 (or here as a PDF)

Air of revolution: how activists and social media scrutinise city pollution

Facebook and Twitter drives are turning concern over breathable air into grassroots campaigns that shame governments

▲ Tourists in masks take selfies during a heavily polluted day in Tiananmen Square, Beijing. Photograph: Alexander F Yuan/AP

In Krakow, Poland, lawmakers recently banned the burning of coal to heat homes after activists pressured them with a Facebook campaign

Screenshot of The Guardian webpage, featuring their Cities section: https://www.theguardian.com/cities/2014/jan/31/air-activists-social-media-pollution-city (or here as a PDF)

❖ Further examples of journalism about citizen science in different languages (optional)

The examples in this list are sorted per language (alphabetically) and within each language per resource type (text, podcast, video, etc.). Each link is accompanied by a short description of the news.

Dutch

Text

- De sneeuw is gesmolten, maar duizenden plastic borstelharen van veegmachines blijven nog jaren liggen. Highlighting the problem of plastic litter, and the Plastic Spotter action that engages Citizen Scientists in not only identifyin types and sources of litter in the canals, but also takes the plastic out of the canals.

- Burgerwetenschap is in opkomst. 'Vergeet niet dat veel wetenschappers vroeger amateurs waren'. Highlighting the problem of plastic litter, and the Plastic Spotter action that engages Citizen Scientists in not only identifyin types and sources of litter in the canals, but also takes the plastic out of the canals.

- Speur mee, tel mee, denk mee - De burgerwetenschap is onmiskenbaar in opkomst. The growth of Citizen Science, with a range of examples, profiled participants, and links to the initiatives to invite readers to also take part

- Vier dingen die jij zelf kunt doen voor biodiversiteit. An article about positive things that you can do for nature to improve biodiversity and support pollinators, that includes examples of being a Citizen Scientist, with links to many initiatives.

- Kinderen onderzoeken tijdens IVN Slootjesdagen hoe gezond de sloot in Utrecht is. Local news about school children engaging with an annual biodiversity initiative, with informationn about what is learned each year.

- Citizen Science: bewoners 'monitoren' biodiversiteit langs fietspad A15. Local news about a CS biodiversity initiative, featuring participants, supporters, and with information about how to get involved yourself

- Amateur wettenschapper. Different projects in The Netherlands

English

Text

- World is home to 50bn wild birds, 'breakthrough' citizen science research estimates. Article about a research carried out by the University of Southern Wales

- The power of people to manage public health. The story of one citizen science project managed to gather and process real-time information and insights faster than most, propelling the power of people-led science combined with technology to the fore.

- The rise of citizen science. Article that enhances how citizen science builds on our very human sense of curiosity.

French

Text

- « Cueilleur de météorites » : Comment les sciences participatives permettent aux citoyens d'aider la recherche. The article shows how astronomers and astrochemist involve citizens and use the data that they provide them.

- Sciences participatives : les Français prêts à participer à la recherche. Article introducing citizen science, called here participatory science, and how and why people get involved in it.

German

Text

- Wie die Forschung von der Mithilfe der Bürger profitiert. News about how science uses data provided by citizens and how this makes research more inclusive and open.

- Pack die Lupe aus: "Citizen Science" auch in Österreich gefragt. Local news about CS in general and the Austrian platform Österreich forscht and its blog

- Mitmachen bei der Forschung - aber richtig!. National newspaper article on citizen science in general

- Citizen Science: Wiener Wurzeln und Wahrnehmungen. National newspaper article on the history of citizen science in Vienna

- Erdkröte mit Fell. Text on citizen science in general with several examples of citizen science projects

- Die Geschichte der Bürgerwissenschaften. Text on the online portal of the Austrian national broadcasting company ORF about the book "The Science of Citizen Science"

- Citizen Science Erkenntnisgewinn für alle möglich machen. Text on opening research and innovation processes on the page of the (German) Federal Ministry of Education and Research

Hungarian

Text

- Így segítik a civilek a kutatók munkáját. Article introducing the EU-Citizen.Science platfrom and providing some example from Hungary on how citizens can contribute to scientific research.

Italian

Text

- Una giornata di studio nella Riserva Naturale Orientata Monte Velino di Magliano dei Marsi sui coleotteri. Local news about MIPP (Monitoring of Insects with Public Participation) Life project workshop: presentation of the project and its Citizen Science characteristics (the role of Citizens in Scientific Research and how they can contribute to the monitoring).

- Un raro pipistrello identificato a Trento grazie alla Citizen science. Text on an online scientific portal about a rare Chiroptera species found in the city of Trento (North Italy) by a Citizen. The article focuses on the importance of Citizen Scientists observations for the Scientific community.

- Ambiente, al via “ReATTIVI”: la campagna di monitoraggio partecipato dell’inquinamento di Roma. Local news about ReATTIVI Citizen Science project on urban pollution monitoring carried out thanks to the collaboration between Citizens and Scientists. The monitoring concerns air, soil and water compartments in the city of Rome and the around areas.

- MicroMar: monitorare le microplastiche nel Mediterraneo con la citizen science. National news about MicroMar Citizen Science project: explanation about plastic pollution into the sea and how the Citizens can help Scientists to study this issue through the Citizen Science.

Lithuanian

Text

- Lietuvė mokslininkė – apie piliečių mokslą arba „mokslininkus neprofesionalus“. Article introducing the concept of citizen science

Spanish

Radio

- ¿Qué será Seró? Proyecto de ciencia ciudadana ‘los vigilantes del aire’. A regional radio channel in Spain talks about a CS project "Los vigilantes del aire" (translated: the guards of the air) in the first half of the transmission.

Text

- Un proyecto de narices en Kampala. The capital of Uganda joins a global network of cities that use co-creation tools and citizen science to alleviate bad odours and improve urban air quality.

- La UNC forma parte del comité asesor de ciencia abierta y ciudadana//National University is part of the Committeee for Open Science for the People. News about an Argentinian university taking part in a local and territorial committee for CitSci.

- Más del 50% de la información científica sobre biodiversidad procede de los ciudadanos. More than 50% of the data collected in the Global Biodiversity Information Facility (GBIF) database comes from citizen science input. Many biodiversity data refer mainly to species distribution (whether a particular species is present or absent in a location). In this article they mention the Natusfera project.

- Un grupo de niños recopila datos sorprendentes sobre 83especies de animales. Students from USA, India, Mexico and Kenya have participated in the eMammal citizen science project. This project consists of setting camera traps that capture pictures when they sense movement. Children collect the data, upload the pictures to the eMammal software and identify these animals (this identification is verified by a researcher). This data is useful for addressing important scientific and conservation questions, while the pictures provide a unique view into the hidden world of wildlife.

- "La campaña de ciencia ciudadana de LIBERA caracteriza 461 residuos abandonados en entornos fluviales de La Rioja". The LIBERA citizen science campaign aims to raise awareness about litter and the effects on the environment. Almost 5,000 people have helped collecting debris in fluvial ecosystems. It was possible to collect data on the volume, quantity, and typology of 6.4 tons of abandoned waste.

- Ciencia ciudadana para rastrear la expansión de mosquitos por Europa. In this article they talk about MosquitoAlert. Thanks to the data provided by citizens, scientists were notified about the presence of Japanese mosquitos in the north of Spain, which was rather weird. Tracking mosquito's distribution can help develop environmental strategies and improve policy making against invasive species and the emergence of possible new diseases.

- ¿Cómo colaboran los astrónomos aficionados con la ciencia internacional? This article refers to the different ways of citizen collaboration in astronomy and encourages non-scientist (or amateur scientists) to engage in scientific research via collecting data in different astronomical related fields, such as astrometry or astrophotography. They mention Zooniverse and some of its citizen science projects related with astronomy, for instance, "Planet Hunter" and "Hubble asteroid Hunter".

- As de guía, ciencia marina inclusiva. The citizen science project 'As de guía', settled in the Balearic Islands, educates participants in the scientific method, showing them how research is carried out and encouraging them to be active protagonists in the promotion of marine science and raising awareness of the importance of conserving biodiversity.

TRAINING SUMMARY AND SELF-ASSESSMENT (15 MINUTES)

❖ Introduction (1 min)

We have now completed the training module. Here, we provide a summary of what we have learned and the main "takeaway" points that we covered in the different parts of the unit. You also have an opportunity to take a final quiz and earn a badge and a certificate that you took in this module. This is an opportunity to test your knowledge and see how much you've learned in the past hour and a half.

❖ Summary of the topics that we covered (3.5 minutes)

- **Introduction**

The purpose of the module was to introduce you to citizen science. We have seen that it is a term with a wide meaning and captures a lot of activities. Here we can summarise the things

that we have learned through the range of examples and stories that were covered. We have set it up, so you can look at each question that the section was addressing.

- **What is citizen science?**

We have seen that citizen science includes activities that are done by individuals or by groups, with a common element of participation in scientific research. An individual might be interested in quantifying their health condition and ask scientific questions about the data that they collect, or might be developing a Do-It-Yourself project. Groups of people can come up with their investigation to address a problem, or they might be joining a project that was designed by scientists with a task that is allocated to participants. It has a long history, with examples from weather observation or recording species that can be traced back over a hundred years ago. In citizen science, it is participation that matters. In some cases, it will involve people putting software on their computers, while in other cases, they will initiate and run a project — all these forms of participation are valuable.

- **What are the main terms and concepts?**

We have seen that there are lots of definitions of citizen science, and there are also some uncertainties about exactly what the terms that are being used mean in a specific context. It is therefore a good idea to consider and check what exactly the people who run the project mean. We have seen terms such as crowdsourcing, community science, and community-based participatory research. We also saw that there are many ways to refer to participants — from citizen scientists to volunteers or human sensors. Likewise, we have also seen that there are links between the wider concept of Open Science and citizen science.
We came across concepts such as volunteer thinking, volunteer computing, citizen cyberscience, and civic science. We noticed that projects can be classified by looking at the relationships between scientists and participants — this is the basis for identifying projects as contractual, contributory, collaborative, co-created, and collegial. Most citizen science, in terms of projects and number of participants, in the contributory area. For a lot of people, when they talk about citizen science they think of contributory projects.

- **What are the main issues that we will encounter when reporting on citizen science?**

When reporting on citizen science, we identified four frequently mentioned issues. These are data quality, motivation, the demographic profile of participants, and the benefits that they gain from participation. We've seen that the data quality can be high, given appropriate planning and design. In terms of motivations, we've seen a wide range of reasons from wanting to help science, to personal growth and interest in a topic. We also discussed the benefits such as

science literacy, awareness of issues, and improvement of skills that are relevant beyond citizen science.

- **What are the impacts of citizen science?**

When discussing the impacts of citizen science, we have seen the impacts of scientific research — such as data at locations and scales that would not be possible otherwise. There are also contributions in ideas and insights. At a societal level, citizen science can help address communal problems and provide evidence that can be used in addressing them. Citizen science can also help in addressing policy challenges — from monitoring an environmental condition to addressing the progression towards the sustainable development goals.

- **What kind of stories can be written about citizen science?**

Finally, we have seen that there is a growing collection of articles, long stories, personal profiles, radio programmes, podcasts, and video reports on citizen science. It is a great topic that can be linked to many issues of interest and concern. It can focus on an individual volunteer and their achievement, on a community struggle, or provide “here is something that you can do” within a campaign that a media outlet adopts.

❖ Final quiz (10 minutes)

In Moodle you will find this final quiz. It is an opportunity to revise and assess the knowledge that you've gained from the unit. The questions are using knowledge from all the parts of the course, and you are allowed to take the quiz more than once. Let's see how much you've learned!

❖ Conclusion from the course team (1 min)

We've come to the end of this training about citizen science that we have honed thinking in a very specific audience: journalists. We hope that the contents that we put together were clear, compelling, inspiring and will help you to trace projects and people working on the topics that you regularly cover as a journalist. We also hope that as a learner, you are now equipped with the fundamental knowledge of this very broad, complex and expansive field and the overview that we intended to give has broadened your conceptions and opened room for new ideas. Hope that you’ve enjoyed the course and remember you can reuse all the content of this course. We highly encourage you to look out in your region and get in contact with people with expertise in citizen science and a local.

FURTHER INFORMATION

❖ Further contact details

For more information about citizen science, you can contact the European Citizen Science Association at https://ecsa.citizen-science.net/ or send an email to ecsa-admin@mfn.berlin. In the USA, you can contact the Citizen Science Association https://citizenscience.org/ and in Australia, contact the Australian Citizen Science Association https://citizenscience.org.au/.
The academic journal Citizen Science: Theory and Practice is dedicated to the latest developments in the field, although many papers on citizen science are now appearing regularly in many academic journals. As you've seen in the course, citizen science adapt itself to the specific scientific field in which it is operating, so it is a good idea to approach people who are publishing on citizen science within this specific field.
There are also two books that can be useful and are available with free access. They are called Citizen Science and The Science of Citizen Science. The US PBS series the Crowd and the Cloud is another useful resource.

SOURCES AND ACKNOWLEDGEMENTS

❖ Sources for the material in the course

We have used a wider range of sources for the material in this training unit. The list below is organised according to the sections of the unit.

- **Section 1: Citizen Science in Five Stories**

This section is based on information from multiple sources. The purpose of this section is to provide more details, in case that you would like to learn more about these issues:

Story 1 - Come Rain or Shine

Information and images were provided by the report "Volunteers for Weather, Climate and Water" by the World Meteorological Organization, report WMO-919 from 2001. Further information about the UK Met Office WOW was provided from the Met Office WOW brochure "Get Involved and join our WOW community" (2017).

Story 2 - Observing the first satellites

This section is based on Wikipedia articles about the International Geophysical Year, Fred L. Whipple, Operation Moonshot, and Sputnik. There is another great source on Moonwatch at

➢ Dickinson, D. 2013. Citizen Science, Old-School Style: The True Tale of Operation Moonwatch. https://www.universetoday.com/100744/citizen-science-old-school-style-the-true-tale-of-operation-moonwatch/

And in a more academic version in:

- McCray, W. 2006. Amateur Scientists, the International Geophysical Year, and the Ambitions of Fred Whipple. *Isis, 97*(4), 634-658. doi:10.1086/509947

Story 3 - From buckets of resistance to balloon recording of oil spill

Sources about Louisiana Bucket Brigade are:

- Mack, L. 2013. Anne Rolfes - Interview with the founder of Louisiana Bucket, MyNewOrleans.com https://www.myneworleans.com/anne-rolfes/
- Stoll, S.L., 2017. 6 Ways Citizens Across the U.S. Are Using Science to Build a Better World, Yes! Magazine, Spring 2017 https://www.yesmagazine.org/issue/science/2017/02/28/6-ways-citizens-across-the-us-are-using-science-to-build-a-better-world
- Louisianna Bucket Brigade, 2021. About the bucket https://labucketbrigade.org/pollution-tools-resources/the-bucket/
- Wikipedia 2021. Communities for a Better Environment. https://en.wikipedia.org/wiki/Communities_for_a_Better_Environment
- POV, 2002. The Bucket Brigade. http://archive.pov.org/fenceline/the-bucket-brigade/
- Public Lab, 2021. About us https://publiclab.org/about

Story 4 - Chris, Kevin, and Hanny and the Galaxies

The sources about Galaxy Zoo are:

- Adams, T. 2012. Galaxy Zoo and the new dawn of citizen science https://www.theguardian.com/science/2012/mar/18/galaxy-zoo-crowdsourcing-citizen-scientists
- Gray, R. 2017. Galaxy Zoo: Citizen science trailblazer marks tenth birthday https://www.bbc.co.uk/news/science-environment-40558759
- Wikipedia 2021. Galaxy Zoo https://en.wikipedia.org/wiki/Galaxy_Zoo

Story 5 - Patient, heal yourself! Patients monitoring and self-management

More about Sara Riggare on her website https://www.riggare.se/about/

- **Section 2: terminology and classification**

Sources – Part A

Citizen Science

- Bonney, R. (1996). Citizen science: A lab tradition. *Living Bird* 15(4): 7–15.

- Haklay, M., Motion, A., Balázs, B., Kieslinger, B., Greshake Tzovaras, B., Nold, C., … Wehn, U. (2020, April 1). ECSA's Characteristics of Citizen Science. Zenodo. http://doi.org/10.5281/zenodo.3758668
- Haklay, M., Dörler, D., Heigl, F., Manzoni, M., Hecker, S., Vohland, K. (2021). What Is Citizen Science? The Challenges of Definition. In K. Vohland, A. Land-Zandstra, L. Ceccaroni, R. Lemmens, J. Perelló, M. Ponti, R. Samson, K. Wagenknecht (Eds.), The Science of Citizen Science (pp. 13–34). Springer. http://doi.org/10.1007/978-3-030-58278-4
- Irwin, A. (1995). Citizen Science: A study of people, expertise and sustainable development. London: Routledge.
- Oxford English Dictionary. (2014). Citizen science. Oxford: Oxford University Press.

From citizen science to community science and back and Citizen scientists, volunteers…?

- Cooper, C. B., Hawn, C. L., Larson, L. R., Parrish, J. K., Bowser, G., Cavalier, D., Dunn, R. R., Haklay, M., Gupta, K. K., Jelks, N. O., Johnson, V. A., Katti, M., Leggett, Z., Wilson, O. R., Wilson, S. (2021). Inclusion in citizen science: The conundrum of rebranding. *Science*, 372(6549), 1386-1388. DOI: http://doi.org/10.1126/science.abi6487
- Dosemagen, S. (2020) Exploring the Roots: The Evolution of Civic and Community Science. Available at: https://sdosemagen.medium.com/exploring-the-roots-the-evolution-of-civic-and-community-science-80dd899335cb
- Eitzel, M. V., Cappadonna, J. L., Santos-Lang, C., Duerr, R. E., Virapongse, A., West, S. E., … Jiang, Q. (2017). Citizen Science Terminology Matters: Exploring Key Terms. *Citizen Science: Theory and Practice*, *2*(1), 1. DOI: http://doi.org/10.5334/cstp.96
- Haklay M., Mazumdar S., Wardlaw J. (2018) Citizen Science for Observing and Understanding the Earth. In: Mathieu PP., Aubrecht C. (eds) Earth Observation Open Science and Innovation. ISSI Scientific Report Series, vol 15. Springer, Cham. https://doi.org/10.1007/978-3-319-65633-5_4

Open Science

- DITOs consortium, (2017). *Citizen Science and Open Science: Synergies and Future Areas of Work*. DITOs policy brief 3. Available at: https://discovery.ucl.ac.uk/id/eprint/10043574/
- OECD (2017) 'Making open science a reality', OECD Science, Technology, and Industry Policy Papers. Available at: https://doi.org/10.1787/5jrs2f963zs1-en
- Vohland, K. & Göbel, C. (2017). Open Science und Citizen Science als symbiotische Beziehung? TATuP Zeitschrift für Technikfolgenabschätzung in Theorie und Praxis, [online] 26(1-2), p. 18-24. https://doi.org/10.14512/tatup.26.1-2.18
- Wikipedia (2021). Open Science. Available at: https://en.wikipedia.org/wiki/Open_science

Sources – Part B

This part draws heavily on the "Citizen Science Typologies" training module on Moodle that has been designed by members of the Extreme Citizen Science (ExCiteS) research group at University College London (UCL) and is available here: https://moodle.eu-citizen.science/course/view.php?id=12

- Haklay M. (2013) Citizen Science and Volunteered Geographic Information: Overview and Typology of Participation. In: Sui D., Elwood S., Goodchild M. (eds) Crowdsourcing Geographic Knowledge. Springer, Dordrecht. https://doi.org/10.1007/978-94-007-4587-2_7
- Haklay M., Mazumdar S., Wardlaw J. (2018) Citizen Science for Observing and Understanding the Earth. In: Mathieu PP., Aubrecht C. (eds) Earth Observation Open Science and Innovation. ISSI Scientific Report Series, vol 15. Springer, Cham. https://doi.org/10.1007/978-3-319-65633-5_4

- **Section 3: Challenges and Opportunities in Citizen Science**

This section is based on information from multiple sources. The purpose of this section is to provide more details, in case that you would like to learn more about these issues:

Data Quality

See the section on additional information on data quality where you will find additional information.

Motivation

The main source for this section is a report by Hilary Geoghegan and her colleagues that provides a comprehensive analysis of motivation within environmental citizen science.

Geoghegan, H., Dyke, A., Pateman, R., West, S. & Everett, G. (2016) *Understanding motivations for citizen science. Final report on behalf of UKEOF*, University of Reading, Stockholm Environment Institute (University of York) and the University of the West of England.

Benefits of participation

The sources for this section are the following:

- For the report on the number of participants in the 2021 Big Garden Birdwatch, see https://www.discoverwildlife.com/news/majority-of-garden-bird-species-recorded-in-the-big-garden-birdwatch-2021-suffer-decline/

- There are many sources about the level of education in different countries, and for the up to date statistics we used: https://en.wikipedia.org/wiki/List_of_countries_by_tertiary_education_attainment
- The section mentions an analysis of participation in environmental citizen science, and this is available at Pateman, R. M., Dyke, A., & West, S. E. (2021). The Diversity of Participants in Environmental Citizen Science. Citizen Science: Theory and Practice.
- The section also used information from Haklay, M. (2018). Participatory citizen science. In Haklay M., Hecker S., Bowser A., Makuch Z., Vogel J., & Bonn A. (Eds.), Citizen Science: Innovation in Open Science, Society and Policy (pp. 52-62). London: UCL Press. Retrieved June 10, 2021, from http://www.jstor.org/stable/j.ctv550cf2.11

- **Section 4: Social, Economic and Political Impacts**

The sources that were used for this section are:

Scientific impact

- Jackson, M., & Manning, P. (n.d.). *The next invasion of insect pests will be discovered via social media*. The Conversation. Retrieved 31 May 2021, from http://theconversation.com/the-next-invasion-of-insect-pests-will-be-discovered-via-social-media-143527
- Galaxy Zoo: Citizen science trailblazer marks tenth birthday. (2017, July 10). *BBC News*. https://www.bbc.com/news/science-environment-40558759
- *Citizen scientists deserve more credit, researchers argue*. (n.d.). ScienceDaily. Retrieved 16 June 2021, from https://www.sciencedaily.com/releases/2019/12/191203093028.htm
- Masterson, rew, & Public, S. in. (n.d.). *Citizen scientists deserve more credit, researchers argue*. Retrieved 16 June 2021, from https://phys.org/news/2019-12-citizen-scientists-credit.html

Societal impact

Tomorrow's Cities: How Barcelona shushed noise-makers with sensors. (2018, June 2). *BBC News*. https://www.bbc.com/news/technology-41015486

Political impact

- Pecl, G., Gillies, C., Sbrocchi, C., & Roetman, P. (2015). *Building Australia through citizen science. An Occasional Paper for the Office of Chief Scientist.* https://doi.org/10.13140/RG.2.1.1744.8409
- Fraisl, D., Campbell, J., See, L., Wehn, U., Wardlaw, J., Gold, M., Moorthy, I., Arias, R., Piera, J., Oliver, J. L., Masó, J., Penker, M., & Fritz, S. (2020). Mapping citizen

science contributions to the UN sustainable development goals. *Sustainability Science*, *15*(6), 1735–1751. https://doi.org/10.1007/s11625-020-00833-7

- Fritz, S., See, L., Carlson, T., Haklay, M. (Muki), Oliver, J. L., Fraisl, D., Mondardini, R., Brocklehurst, M., Shanley, L. A., Schade, S., Wehn, U., Abrate, T., Anstee, J., Arnold, S., Billot, M., Campbell, J., Espey, J., Gold, M., Hager, G., … West, S. (2019). Citizen science and the United Nations Sustainable Development Goals. *Nature Sustainability*, *2*(10), 922–930. https://doi.org/10.1038/s41893-019-0390-3

Raising awareness

- *Citizen Science—Engaging and Empowering Local Communities | Oxfam in Asia*. (n.d.). Retrieved 31 May 2021, from https://asia.oxfam.org/latest/policy-paper/citizen-science-engaging-and-empowering-local-communities
- Saunders, M. E., Roger, E., Geary, W. L., Meredith, F., Welbourne, D. J., Bako, A., Canavan, E., Herro, F., Herron, C., Hung, O., Kunstler, M., Lin, J., Ludlow, N., Paton, M., Salt, S., Simpson, T., Wang, A., Zimmerman, N., Drews, K. B., Moles, A. T. (2018). Citizen science in schools: Engaging students in research on urban habitat for pollinators. *Austral Ecology*, *43*(6), 635–642. https://doi.org/10.1111/aec.12608
- Randi Wallmichrath. (2018). *Science with and for Society—Success Stories* (p. 28). German Aerospace Center DLR Project Management Agency. https://www.sisnetwork.eu/media/sisnet/SiS_net_Success_Stories_Booklet.pdf

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