Co-funded by
the European Union

CitSci4

PROJECT RESULT 1

Guide on Deaf and Hard of Hearing Adults' Engagement in Citizen Science Projects for Climate Change

CITIZENS IN POWER

IRSAM

RITE

Web2Learn
Open, social learning

Co-funded by the European Union

The CitSci4All project is co-financed by the ERASMUS+ programme of the European Union (2022 -2024). This guide reflects the views of the authors, and the European Commision cannot be held responsible for any use which may be made of the information contained therein. Project Number: 2021-1-FR01-KA220-ADU-000035221.

Co-funded by the European Union

PARTNERS

Citizens in Power is a Cypriot non-for-profit educational and research organization with experience in facilitating the active participating of the public in civic life through the provision of innovative material and trainings.

IASIS is a Greek NGO that is active in the fields of social inclusion, mental health and education, offering counselling and psychosocial support to marginalized groups.

IRSAM is a French Institution specializing in hearing impairments and sensory disabilities in both children and adults. It supports people with disabilities, in specialized workspaces, in mainstream settings and in learning and training centers.

IST is an Italian Institute and a non-for-profit foundation, providing a wide range of educational and training services and activities, as well as, support for the DHH and other linguistic and cognitively impaired children and adults.

RITE is a Cypriot non-for-profit organization that seeks to contribute to scientific and applied research with the purpose of reinforcing innovation, technology transfer, knowledge consolidation and policy reform.

Web2Learn is a Greek organization specializing in open education, science and policy, as well as, social connectivity. It has experience in civic engagement strategies for environmental preservation in a range of citizen science projects.

CONTENTS

Co-funded by the European Union

Co-funded by the European Union

INTRODUCTION: *Why a Guide for DHH engagement in Citizen Science Projects for Climate Change?*

Climate change is a pressing issue with global ramifications that requires everyone's attention and engagement. More importantly, everyone should be given the choice and the opportunity to be involved. Citizen Science is the practice of engaging the public in scientific research practices and tasks for the purposes of collecting information, raising awareness, or providing solutions to research questions (EU-Citizen.Science, 2020). The International Disability Alliance (IDA, 2021) reports that "Climate Change is Our Crisis too". However, when information on the climate crisis and ways to address it is not often provided in accessible formats, such as "sign language for deaf persons…" then climate change action becomes inaccessible. Provided inclusive methodologies and adapted tools are created, citizen science can offer the opportunity to traditionally excluded communities, such as the Deaf and Hard of Hearing, to be involved in the fight against climate change and open-up avenues of meaningful engagement with policy decision making. This can lead to the enactment of disability-inclusive policies that enhance rather than undermine the human rights of persons with disabilities.

By creating this *"Guide for the Deaf and Hard of Hearing engagement in citizen science projects for climate change*" the CitSci4All consortium aims to:

- **Raise Awareness** as to the possibilities and opportunities offered by citizen science initiatives and projects.
- **Facilitate the social and scientific inclusion** of Deaf and Hard of Hearing adults in matters of climate change.

Although this guide is directed at Deaf and Hard of Hearing Trainers, it is the ambition of the CitSci4All project that this guide raises awareness and incentivizes "experts" and "non-experts" alike to create inclusive and accessible methodologies for the inclusion of the Deaf and Hard of Hearing in citizen science projects.

Co-funded by the European Union

The Guide's Structure

The creation of this guide was influenced by a series of Deaf and Hard of Hearing Trainers' survey responses and interviews, as well as citizen science expert interviews. Across the four national contexts (France, Italy, Greece, and Cyprus) a total of 64 Deaf and Hard of Hearing trainers provided information, insights, and guidance through surveys, whilst nine participated in interviews. Deaf and Hard of Hearing trainers offered their thoughts on the level of and barriers to the participation of DHH adults in environmental issues and projects. The consortium also consulted with citizen science experts on the topics, among others, of inclusion and widespread participation in citizen science projects and the benefits of citizen science for climate change. Their suggestions and feedback informed both the structure of this Guide and the manner by which the information is contextualized.

Chapter One is aimed as a brief introduction to citizen science, climate change and the global environmental crisis. Selective examples of citizen science projects are used here as a way of explaining some of the methods, approaches and participatory levels or activities used in citizen science projects. The impact of climate change on different habitats and human livelihoods makes climate change an issue of utmost significance. The ways in which citizen science can be utilized in the fight against climate change are outlined in this chapter through examples of three European Union funded citizen science projects on climate change. The latter are significant not only in generating new knowledge on climate change issues and testing new solutions to local climate change impacts, but also in spreading that knowledge across the globe through local participation. Therefore, citizen science becomes instrumental in facilitating environmental literacy, active citizenship, and education for climate change coalition.

Albeit the many benefits of citizen science for the participant and society, one of its longest standing critiques is the lack of diversity in environmental citizen science participation. **Chapter Two** takes a critical look at the current bias in participation in citizen science projects and argues in favor of widening diversity in participation, highlights the benefits of

Co-funded by the European Union

inclusion and active citizenship for climate action, as well as the benefits for disability and social participation.

Chapter Three outlines the benefits of participation in citizen science projects as a way of enhancing active citizenship and capacity building for the Deaf and Hard of Hearing. It showcases the significance of breaking down communication barriers in mutually beneficial and inclusive societies. In this chapter, the input and insights gathered from DHH trainers and citizen science experts, either through surveys or interviews, as part of Project Result 1 field research and data collection activities is presented. The ways to facilitate inclusion in citizen science projects, as well as the ways in which Deaf and Hard of Hearing adults and trainers can be meaningfully engaged are discussed.

The consortium would like to extend its gratitude to those Deaf and Hard of Hearing Trainers and citizen science experts that participated in the data collection phase of Project Result 1. Their input has been insightful and their guidance instrumental for the creation of this guide.

Co-funded by the European Union

GLOSSARY

Citizen Science

Citizen science uses the collective strength of communities and the public to identify research questions, collect and analyse data, interpret results, make new discoveries, and develop technologies and applications. This is done to understand and solve environmental and social problems (EPA, 2021).

Participant

The term participant is used throughout this guide instead of “citizen” or “citizen scientist” to define anyone identified as “non-expert” that is involved in a citizen science project.

Climate Change

Climate is broadly defined as the average weather conditions in a location over several years. Therefore, climate change is the marked shift in those weather conditions (United Nations, 2022).

Environment

In the context of climate change and for the purposes of this guide, the environment refers to the natural world and all that it is composed of, such as humans and animals or different natural habitats such as forests and oceans (Encyclopedia Britannica, 2022).

Environmental citizenship

Environmental citizenship is described as the positive behaviors of citizens “who act and participate in society as agents of change in the private and public spheres, through

Co-funded by the European Union

individual and collective actions", to provide solutions to environmental issues (European Network for Environmental Citizenship, 2018).

Active Citizenship

Active citizenship is when people get involved in their communities and through democratic action and principles at all levels, promote the quality of life in a community. It is a form of active participation in political, non-political and the social affairs of a nation.

Deaf and Hard of Hearing Trainers

For the purposes of this guide, the CitSci4All consortium identifies as a Deaf and Hard of Hearing Trainer any professional that works with Deaf and Hard of Hearing adults in any capacity such as educational, supportive, or other. The acronym DHH is going to be used from this point forward in this guide instead of Deaf and Hard of Hearing.

Co-funded by the European Union

CHAPTER 1

WHAT IS CITIZEN SCIENCE FOR CLIMATE CHANGE

Co-funded by
the European Union

WHAT IS CITIZEN SCIENCE FOR CLIMATE CHANGE?

What is Citizen Science?

Citizen science is the involvement of non-professionals in scientific inquiry, a phenomenon that can be traced back as far as the 18th Century (Vetter, 2011). As a modern scientific practice, the term citizen science was coined by Irwin (1995) and Bonney (2009). The European Citizen Science Association (ESCA, 2022) offers the most up-to-date description of citizen science:

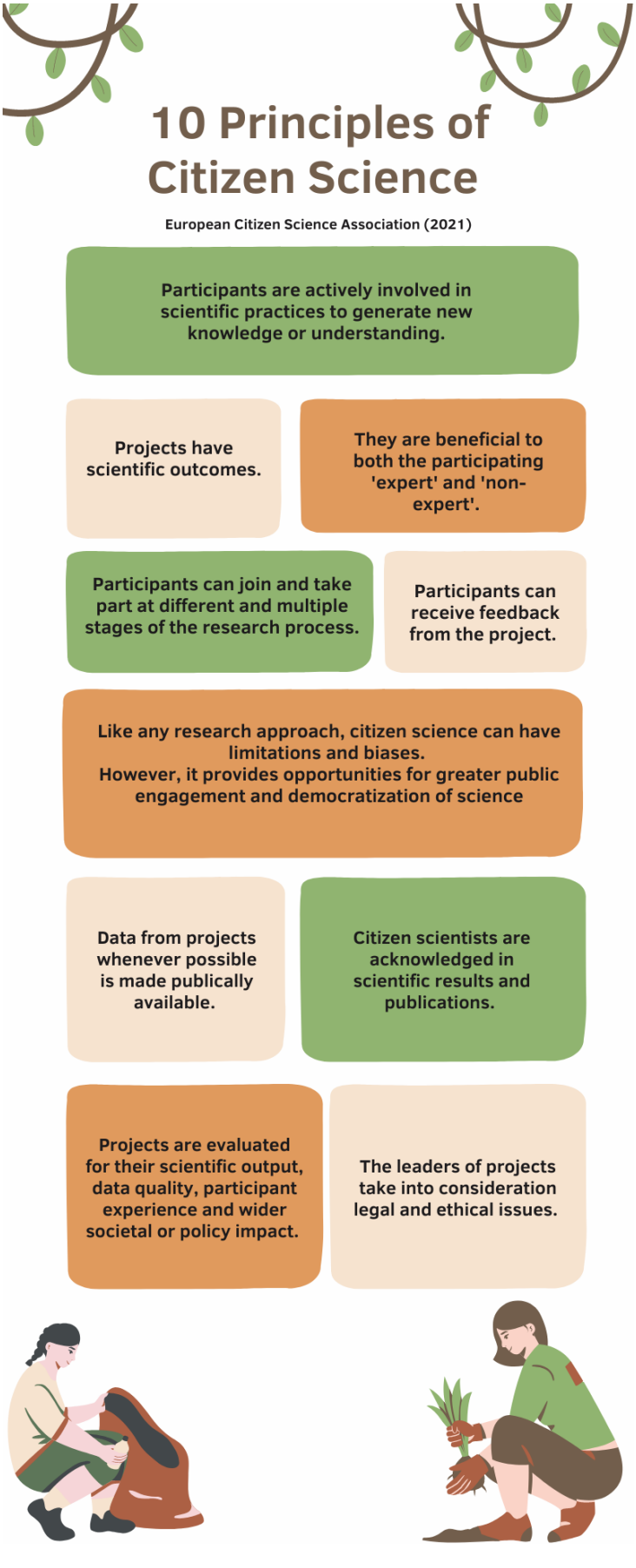
> "Citizen science is any activity that involves the public in scientific research and thus has the potential to bring together science, policy makers and society in an impactful way. Through citizen science, all people can participate in many stages of the scientific process, from the design of the research question to data collection and volunteer mapping, data interpretation and analysis, and to publication and dissemination of results. Citizen science is also an approach to scientific work that may be used as part of a broader scientific activity."

Briefly stated, citizen science refers to a type of research where professional researchers and/or scientists engage with and include the public in scientific research practices and hypotheses. Of importance in this approach, and in similarity to that of inclusive research, is its ability to create avenues of communication and active interaction between "experts" and "non-experts". By doing so, it can potentially "empower people from all walks of life to participate in the scientific process and help advance knowledge in a wide range of scientific disciplines" (Havens & Henderson, 2013, p. 378). Citizen science, as a tool for public engagement and civic empowerment, is an integral part of the CitSci4All project in general and the creation of this guide more specifically and will therefore be elaborated further in Chapter 1 and Chapter 2.

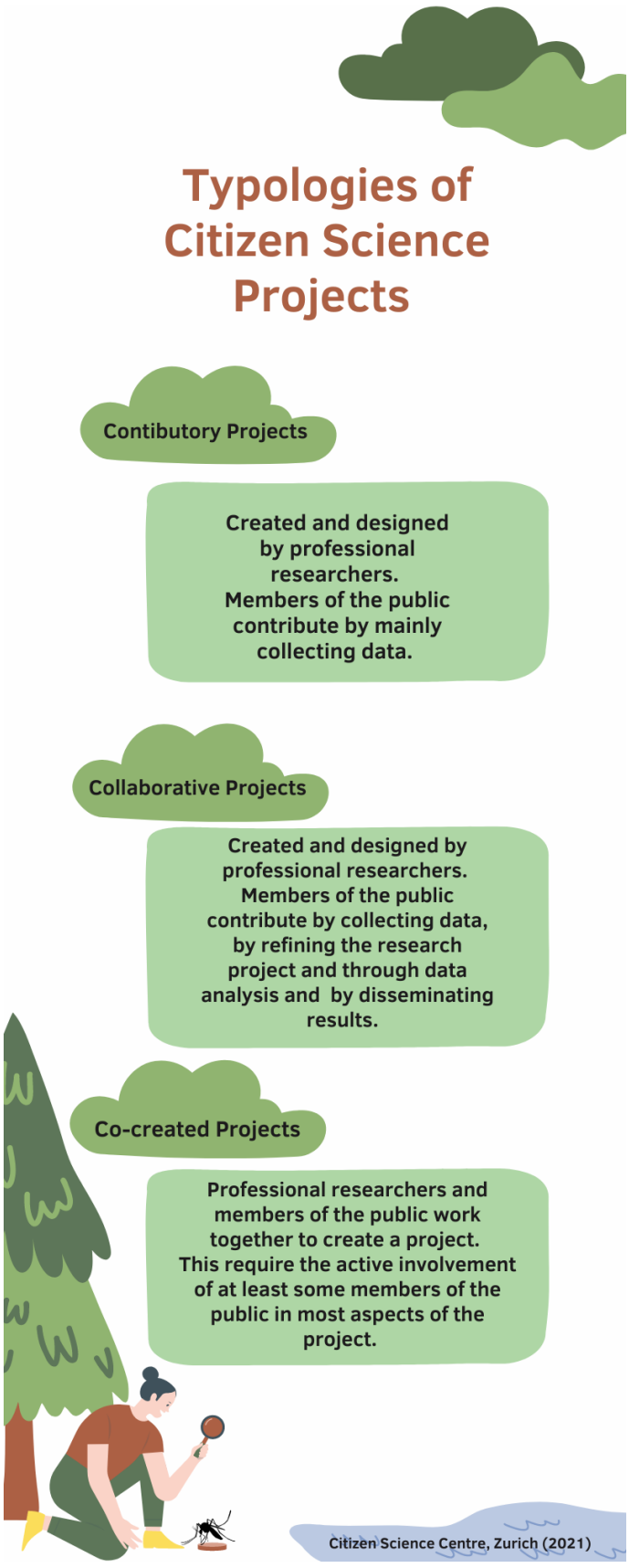
Co-funded by the European Union

The Principles of Citizen Science

As a research approach, citizen science is used in different academic fields for a variety of causes, to answer different and often unrelated scientific questions. Examples of such disciplines could be the social sciences, the humanities, biological and environmental sciences. The flexibility of citizen science as a concept must be recognised, for it is meant to be adapted and developed alongside the different and diverse situations it encounters (EU-Citizen.Science, 2020). This versatility and its ability to develop different methodologies, theories, and techniques undoubtedly plays a role in its emergent role as a tool for conducting research. The same versatility, however, creates a multitude of definitions describing what it entails, ranging from the simplistic to the complex. For this reason, the European Citizen Science Association (2021), to provide a common framework of



Co-funded by the European Union



good practice among those engaged in citizen science, has developed the "10 principles of Citizen Science". These principles offer instructions and guidance as to how a citizen science project should be structured overall. Further information on the characteristics of citizen science in five key aspects; core concepts, disciplinary aspects, leadership and participation, financial aspects and data and knowledge are outlined explicitly in ECSA's characteristic of citizen science (2020).

Co-funded by the European Union

An Introduction to the Participation levels, Methods, and Objectives of Citizen Science: *Examples of Citizen Science Projects.*

"Asking what citizen science is, is like asking what art is" (Costello, 2017).

Although the "10 Principles of Citizen Science" (ECSA, 2021) is an important document identifying those key elements that are essential in creating a citizen science project or initiative, to better understand what it is, one must consider it alongside those activities and practices it creates or is composed of.

For this reason, examples of different citizen science projects, past and presently active, are presented here as a way of outlining the various topics, methods, and participation tasks and/or levels of participation possible in citizen science projects. As mentioned earlier citizen science projects can be found in an array of disciplines, from the fields of agriculture to archaeology, cultural studies, and the social sciences, to that of animal sciences, in the fields of biodiversity and the environmental sciences. Equally, citizen science projects require the public to participate in a variety of scientific processes, at various stages of the research project and in contribution to an array of tasks.

Co-funded by the European Union

Some of these tasks can range from:

The prospective participant is encouraged to engage in those topics that are of significance or interest to him/her and is enabled to determine their level of participation based on the tasks involved.

For example, the eu-citizen.science (2022) portal allows users to filter a multitude of available citizen science projects. These projects can be searched according to location, the status and topic of the project, as well as their difficulty level. The latter is indicative of the variety of research methods and tasks that can be used in citizen science projects.

Co-funded by the European Union

Algforskarsommar Project

One example of a citizen science project that requires participants to be actively involved through hand-on activities is the Algforskarsommar project, organised by Stockholms Universitet (2022).

The project seeks to collect data on the presentation of algae along the Baltic Sea and its differential distribution and appearance in Sweden. The overall aim of the project is to acquire knowledge on the functioning of algae in its ecosystem.

Researchers at Stockholm's University asked the public to contribute to their research efforts through their participation in three distinct tasks whereby the latter would:

- collect data on the small animals that live on seaweed,
- take pictures of seaweed seedlings at the beach edge or on small rocks alongside information on their geographical location (coordinates),
- and investigate when a particular species of seaweed begins its maturation processes in warmer climates.

The latter task required participants to walk alongside the coast of the Bothnian Sea in full moonlight, and by using a thermometer, a hand-held magnifying glass and a white plastic dish (as a replacement for a petri dish), determine whether propagation is at its peak or not.

Training was provided online for all interested participants, either in the form of PdF instructions and/or Video guidance.

Co-funded by the European Union

Star Spotting Experiment

The now completed ‘Star Spotting Experiment” by the Natural History Museum, UK, led by a Swedish citizen science project (2019) recruited the public to participate in a longitudinal experiment with the aim of mapping the extent of light pollution affecting the sky at night.

The main objective of this project was to help researchers understand and calculate the level of artificial light in the night sky negatively affecting human circadian rhythms and animals’ ability to pollinate, such as night-flying insects.

For this reason, the scientific team required the public to actively contribute to scientific research by:

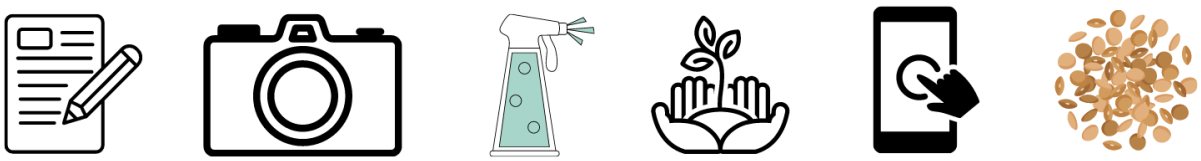
- not only collecting and providing data to the professional team for analysis,
- but by also taking part in the creation of data collection tools that enabled the participants in their efforts.

By creating these devices at home, participants were enabled to participate from wherever they might be.

An instructional video was offered on the museum’s website providing guidance for the prospective participants on how to assemble their device, take measurements and submit their results.

Co-funded by the European Union

INCREASE



Another project that requires active and lengthy participation by the citizen scientist is INCREASE (2020) an ongoing project that started in 2020 and is due for completion in 2026. This is a European wide project on the topics of agrobiodiversity and genetic resources.

Its aim is to raise awareness on legume biodiversity and engage the public in evaluation and conservation activities, as well as, sharing and exchanging seeds through the INCREASE mobile app, specifically developed for the purposes of this project.

By creating collections of well-described and managed genetic resources of common EU legumes (chickpeas, beans, lentils, and lupin) the project aims to enable agronomic sustainability in the EU.

Participants are asked to:

- nurture their beans,
- collect and record information and pictures about them,
- share that information using the INCREASE CSA application provided.
- The bean seeds are shipped to participants, whilst the latter use their own cultivation equipment (soil, pots, sticks) to grow them.

This is an example of a project that is suitable for participation from home, in a do-it-yourself fashion and applicable for a range of age groups.

Co-funded by the European Union

LastQuake

An example of a citizen science project in which public participation is used as a primary source of information is LastQuake (EMSC, 2020).

LastQuake aims to manage seismic disasters by collecting information on seismic events at the precise time of the activity.

Thus, in this setting, the public:

- acts as witnesses
- and submits valuable testimonies on seismic events that due to their transient nature, the scientist might be unable to collect at the spot.

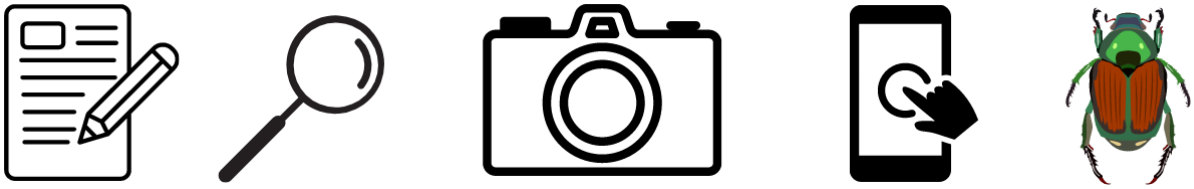
A free and user-friendly application is provided to the public by the research team, thus enabling people to respond immediately after a seismic event takes place.

This immediate response offers invaluable information to the scientific team that will be then facilitated to study populations' reactions to seismic events to manage risk.

Co-funded by the European Union

IPM Popillia – Active 2022

Another project that makes use of the public in urgent information collecting efforts is the currently active IPM-Popillia (2022).



The primary aim of this EU funded Horizon 2020 project is to provide understandings and prevent the spread of the invasive insect species, Japanese Beetle Popillia Japonica. The latter has been deemed as a high priority risk in the new EU Plant health law after it was accidentally introduced to mainland Europe in 2014 (EPPO, 2014). Its destructive nature threatens both urban landscapes in Europe, local biodiversity, and the agricultural sector. This species can quickly spread through the movement of goods and people. Its restriction and the complete eradication of the beetle's established population alongside the Italian-Swiss border is impossible.

- Therefore, the public is recruited as citizen scientists to provide information.
- The public is asked to use the IPM Popillia Citizen Science App.
- Observe and report sightings of the invasive species in agricultural fields or in home gardens and private horticulture facilities, as well as damaged fruits, crops, vegetables, and other plant species.

This will significantly aid scientists' efforts to curb its spread and provide solutions for agricultural destruction.

Co-funded by the European Union

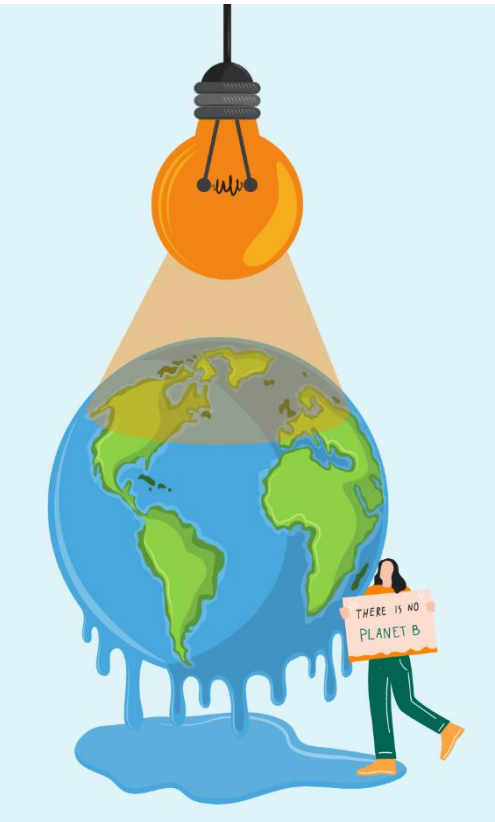
Therefore, irrespective of the multiplicity of potential applications, methodologies, and activities in citizen science projects, “public engagement” and “participation” are crucial and essential elements of citizen science. Whilst the various particulars of a research project can adapt and develop accordingly, without public participation citizen science is non-existent.

At this point, it should be mentioned that although these principles are instrumental in providing a common framework for best practice approaches among the various bodies of scientists embarking in citizen science projects, they regrettably do not adequately define who should be a citizen scientist. These principles acknowledge the contributions of citizen science and the possibilities of those contributions but neglect to include the diversity of potential participants as a possibility to be considered (Carr, 2021). A common criticism of citizen science is that albeit its potential for meaningful engagement and inclusion of the wider public in science and research projects, such a widespread inclusion, is rarely facilitated (Carr, 2021). This topic will be further developed in Chapter 2.

Co-funded by
the European Union

What is Citizen Science for Climate Change?

Although citizen science can and is used in an array of disciplines, as indicated in the examples outlined above, it is explicitly used in the fields of environmental science (Silvertown, 2009). The extent to which environmental issues affect humanity both in terms of the geographic span of the consequences of human action and the need for globalized solutions, necessitate the contribution of exponentially large numbers of participants. One of the most prominent and existentially important issues that humanity faces in the 21st century is climate change.



Citizen science is believed to be instrumental in the efforts to tackle climate change

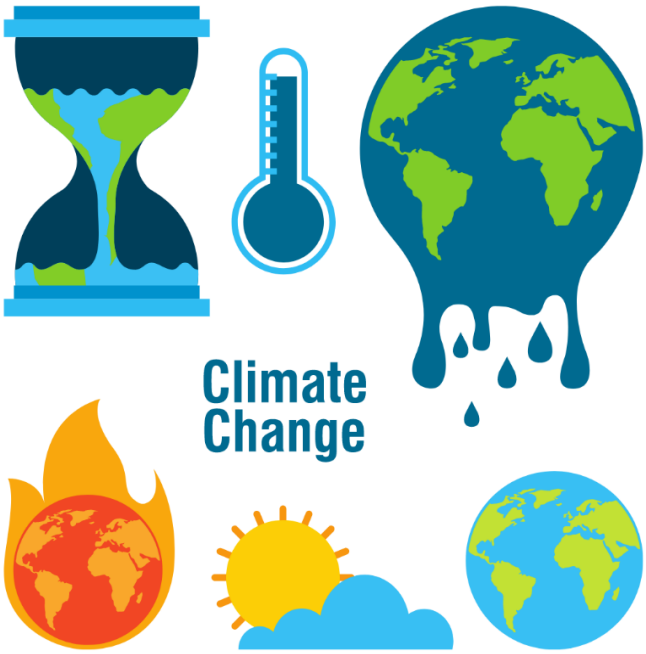
(European Research Executive Agency, 2022)

- Through global participation in research projects, information on climate change issues can be gathered on a grander scale.
- Thus, globalized solutions for a global crisis are created
- Whilst actively engaging and raising awareness within the community on the significance of climate change for humanity.

The following sections are intended as a brief introduction to climate change, its driving factors, impact on natural habitat and human livelihoods, as well as its significance for the European Union. The potential of citizen science in tackling climate change issues through public participation will be explored through an introduction to the various citizen science projects on climate change and environmental sustainability.

Co-funded by the European Union

What is Climate Change? An Introduction.



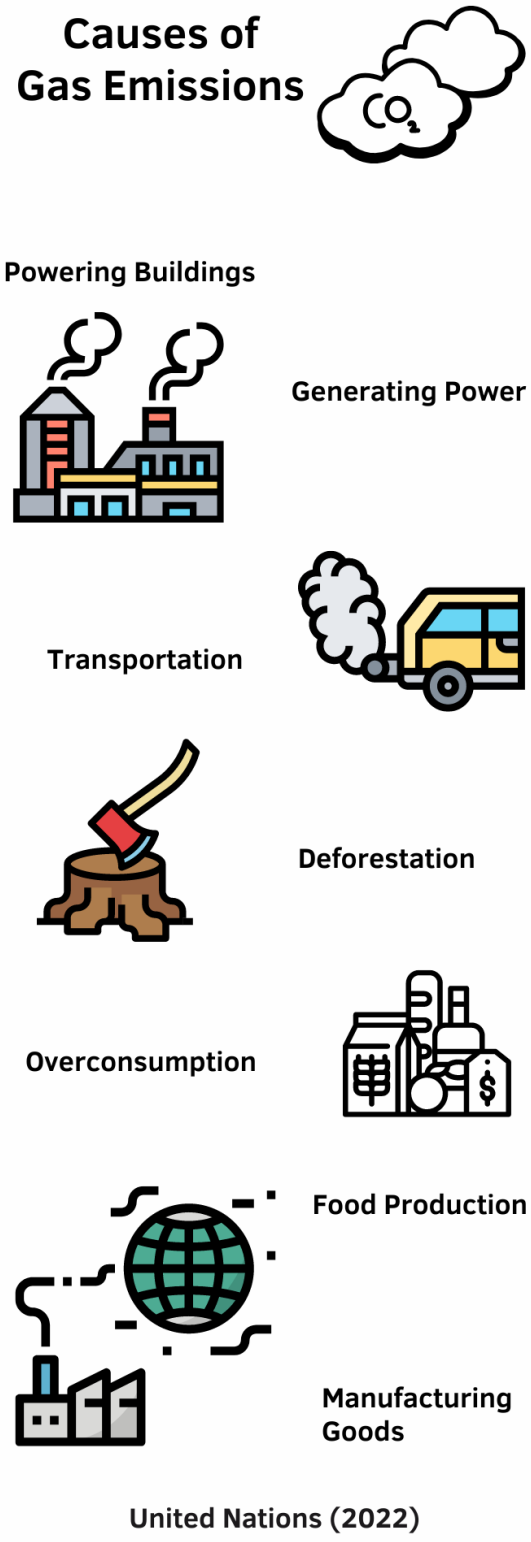
The average weather conditions in a location over several years determine the climate of that location. A marked shift in those climatic conditions describe climate change (United Nations, 2022). World temperatures have been rising exponentially. This climatic change is significantly affecting life on earth. Increasing periods of drought, melting of the ice resulting in higher sea level rises and the consistent extinction of animal species are all consequences of an unprecedented rapid global warming (Buis, 2019).

Global average surface temperature, the term used to track changes in global temperatures, refers to “how much sunlight Earth absorbs minus how much it radiates to space as heat (…) over time” (Lindsey & Dahlman, 2022). The Earth’s temperature has seen an increase of an average of one-degree Celsius from the end of the 19th Century. In every decade since 1981, the global average surface temperature increase has been recorded at 0.08 degree Celsius, raising the overall global average increase at 0.18 degrees Celsius (Lindsey & Dahlman, 2022). A one-degree increase in global average surface temperature is significant, given that “in the past a one-to-two-degree temperature drop was all it took to plunge the Earth into the Little Ice Age” (NASA Earth Observatory, 2022). Interestingly, since 2005 we

Co-funded by
the European Union

have witnessed the “10 warmest years on record”. In fact, seven out of 10 have taken place since 2014 (Lindsey & Dahlman, 2022).

Although the average global temperature increase is estimated at an average of one degree Celsius, many regions have already exceeded 1.5 degrees Celsius above the average temperature levels of the pre-industrial era (Buis, 2019). In fact, “more than one-fifth of all humans live in regions that have already seen warming greater than 1.5 degrees Celsius in at least one season” (Buis, 2019). For example, Pakistan and India have experienced deadly heatwaves in 2015 (Buis, 2019). Given that the average temperature will continue to rise in most land regions, it is projected that at “1.5 degrees Celsius warming about 14 percent of the Earth’s population will be exposed to severe heat waves at least once every five years, whilst at 2 degrees warming that number jumps to 37 percent” (Buis, 2019). Reaching a two-degree Celsius increase means that those deadly heat waves experienced by Pakistan and India in 2015 will become an annual phenomenon (Buis, 2019).



United Nations (2022)

Co-funded by the European Union

Among those regions that will experience the highest temperature increase and thus be severely affected are:

- Central and Southern Europe
- And the Mediterranean (Buis, 2019).

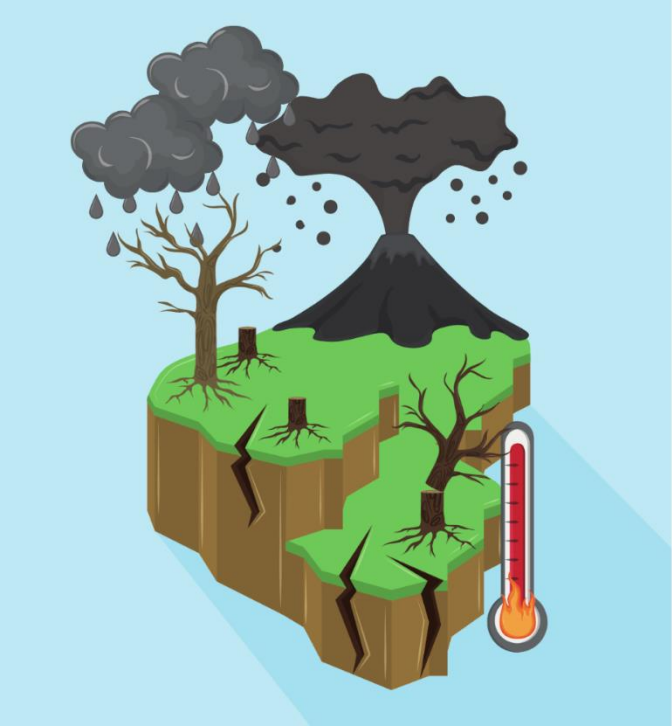
Further, it is estimated that megacities will be exposed to prolonged periods of heatwaves, potentially exposing 350 million people more by 2050 (Buis, 2019). Therefore, although estimations and projections raise the alarm on the significance of climate change action, that dangerous levels of temperature rises have already been reached in some areas, making climate change an issue of utmost priority.

Human activity, left unchecked, is the primary driver of these conditions (IPCC, 2022). Specifically, the burning of fossil fuels for energy use for home and industrial consumption, generates greenhouse gas emissions (United Nations, 2022). These gas emissions behave much like a greenhouse in trapping light and heat and therefore increasing temperatures.

What is the Impact of Climate Change?

In most cases, climate-related risks for both human and natural systems seem to be higher under increased temperatures (Buis, 2019). The severity of these risks depends on “the rate, duration and magnitude of warming; geographic location; levels of development and vulnerability; and on how humans respond through adaptation and mitigation options” (Buis, 2019). Climate change impacts different habitats differently. Whilst some areas might be affected by an increase in heat others might be affected by colder seasons. The following sections attempt to describe some of the impacts of climate change on human lives and the ecosystem by looking more specifically on the increase of droughts, water scarcity, soil erosion and their effects on agricultural practices and food productions, as well as some of those changes affecting biodiversity and ecosystems.

Co-funded by the European Union

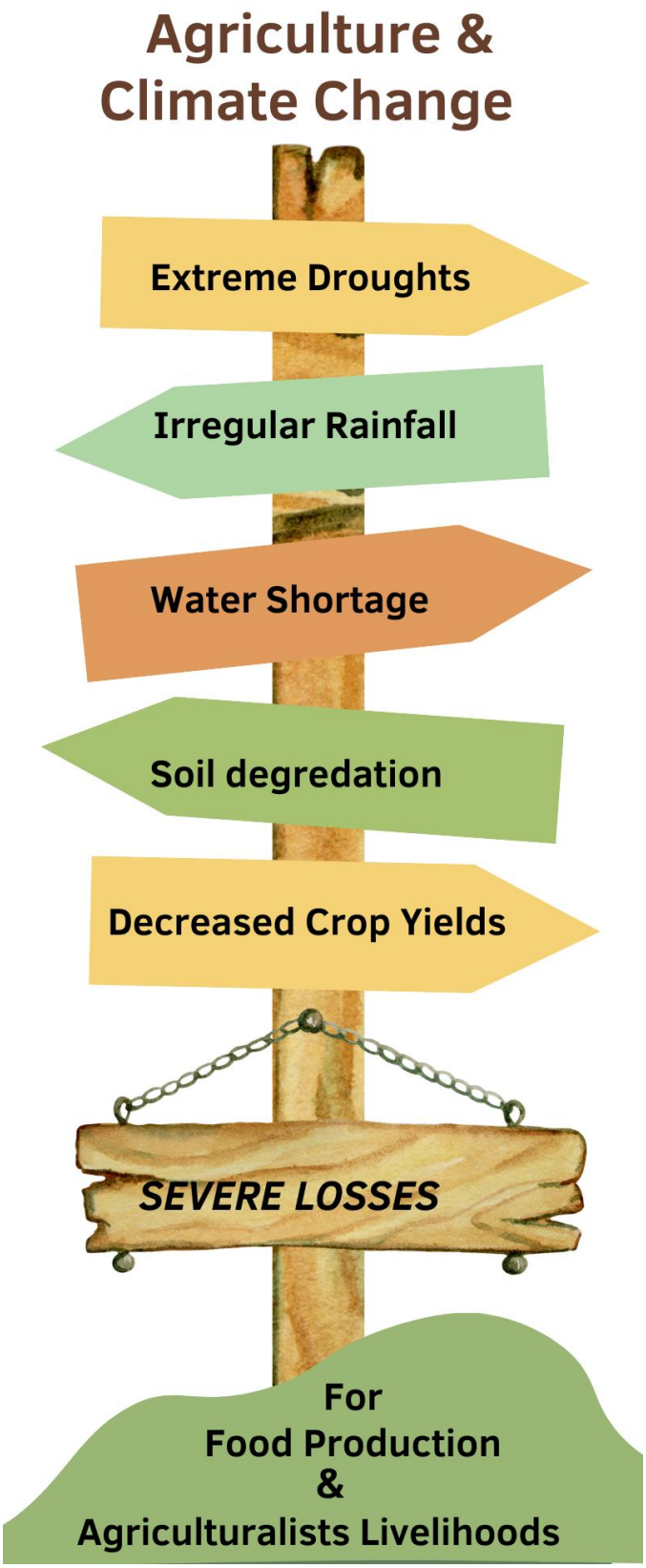


Agriculture and Climate Change

Given that climatic conditions are an essential element of successful agricultural production, climate change will severely impact and affect the agricultural sector (Gammans, et al., 2017). Heat waves, extreme droughts and heavy precipitation events hamper the agricultural successes in many countries. The Mediterranean area, for example, is expected to reach warming levels higher than the global means and therefore, be one of the hardest hit areas in terms of the frequency of extreme droughts (Orlandi, et al., 2020). Moreover, the Mediterranean will experience a considerable decrease in the total rainfall amount in comparison to the more frequent high-intensity rainfall events (Stephanidis & Stathis, 2018). It is projected that somewhere between 184 and 270 million more people will experience water scarcity at 2-degrees Celsius warming (Buis, 2019). For example, given that agriculture remains the most water intensive sector in Cyprus, exceeding more than 60% of the total annual freshwater demand, the extreme drought of 2007 to 2008 led to limited water availability and empty water reservoirs (Papadopoulou, et al., 2020). During this period, decreased crop yields were reported. Therefore, this increasing warming and climatic change will seriously impact the already at-risk agricultural sector in Cyprus (Papadopoulou, et al., 2020).

Co-funded by the European Union

Likewise, the effects of climate change on the livelihoods of small and commercial scale agriculturalists like local farmers, landowners, and orchardists, in the Amalfi Coast in Italy, are significant (Nguyen, et al., 2016). There is a marked decrease in rainfall and an increase in summer droughts indicated by an overall increase in the presence of fog (LICCI, 2015). In addition, the decrease in snowfall led to soil degradation and the species composition of vegetables, changes in crop productivity and an increase in pests with a frequency in the occurrence of invasive weed species (LICCI, 2015). Irregular rainfall patterns because of climate change, as well as the mismanagement of agricultural practices, such as overgrazing and wildfires, make the Mediterranean region particularly susceptible to the adverse consequences of soil erosion (Stephanidis & Stathis, 2018). Soil erosion by water can be a detrimental factor to “natural ecosystems, water resources, and crop productivity” (Stephanidis & Stathis, 2018). For example, in the mountainous region of the Portaikos torrent in Greece, annual soil loss was



Co-funded by
the European Union

measured to be “161,236.5 m^3/year and the erosion rate 1182.1 m^3/year/km^2 (Stephanidis & Stathis, 2018).

The decline in grain production is another way by which the agricultural sector will be impacted. Out of more than a half a million plant species, only four crops make up more than three quarters of our food supply: wheat, rice, maze, and soybean (CFF, 2021). France was ranked fifth in the production of wheat, and second in the production of barley in the period of 2010-2014 (Gammans, et al., 2017). However, warming, and cumulative precipitation patterns in France may disrupt the production of grain. Yields of winter wheat are expected to “decline by an average of 17.2% (…) under the more rapid warming scenarios” (Gammans, et al., 2017) by the end of this century, whereas spring barley yields are expected “to decline by 16.7%–45.8%” (Gammans, et al., 2017).

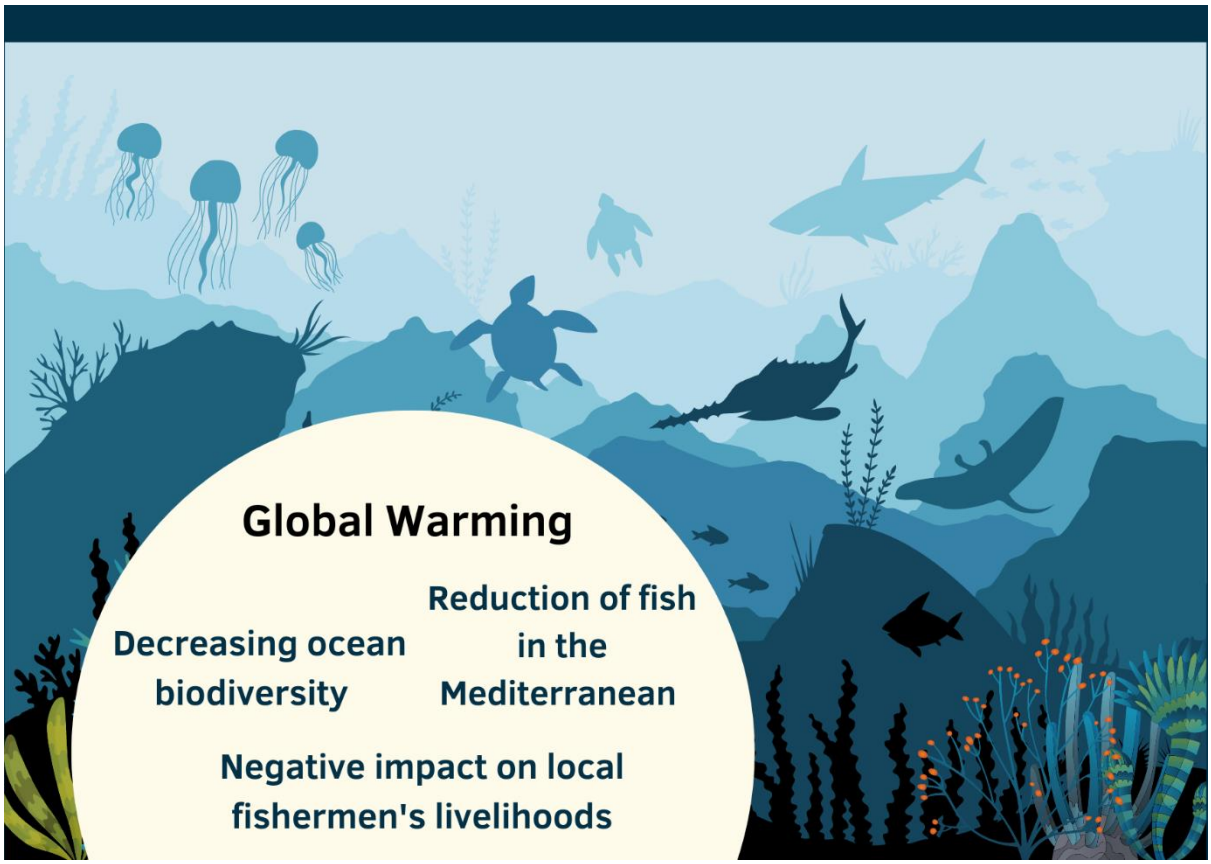
The adaptability of olive crops in the Mediterranean and especially in Italy is another area of concern. The observed increase in aridity conditions in some areas of Italy over the summer period poses a threat. The most optimistic projections show a decrease in olive production in most olive orchards studied (Orlandi, et al., 2020). If the temperature and precipitation patterns continue to change, the risk to olive production will be even greater (Orlandi, et al., 2020). Therefore, this uncurbed trend of climatic changes in the Mediterranean area will result in severe losses for food production and agriculturalists’ livelihoods (Papadopoulou, et al., 2020).

Biodiversity, sustainability, and climate change

Moreover, global warming is having a severe impact on biodiversity and ecosystems. Some of these impacts include loss of species, extinction, and the introduction of invasive species in local habitats (Buis, 2019). For example, ocean warming, acidification, and intense storms will force coral reefs to decline by 70 to 90 % at 1.5 degrees Celsius (Buis, 2019). Such loss will decrease biodiversity and “directly impact about a half billion people worldwide who

Co-funded by the European Union

depend on coral reefs for food, livelihoods, coastal protection, tourism, and other ecosystem services" (Buis, 2019). Lastly, the occurrence of invasive fish species and the destruction they create to local habitats, as well as the reduction of fish in the Mediterranean, have been reported in Italy, Greece, and Spain (Damalas, et al., 2015). This phenomenon negatively impacts local fishermen's livelihoods.



The differential experience of the effects of climate change

Although climate change affects all humans in one way or another, it disproportionately impacts disadvantaged and vulnerable populations and those communities that are depended on agricultural or coastal resources. According to Buis (2019) "climate change increases people's susceptibility to climate related poverty". Examples of the negative impacts include, but are not limited to, heat-related illnesses and higher mortality rates, reduced food security and risks to economic growth (Buis, 2019). According to Vladimir Cuk,

Co-funded by the European Union

executive director of the International Disability Alliance (IDA, 2021) “When disasters such as flood, cyclones or heat waves happen, persons with disabilities are often left out of assistance plans. We see climate mitigation plans being adopted without considering the consequences for persons with disabilities. This all means that to climate decision makers, we do not exist”. In this context, IDA (2021) highlights the importance of disability inclusive climate actions that meaningfully integrate persons with disabilities in climate-related education, awareness, public participation, disaster plans and sustainable development.

What are the solutions? EU Climate Action and the Global Environmental Crisis.

Although changes to climate are already set in motion and some of its effects are irreversible for thousands of years to come, confident and sustainable reductions in carbon dioxide emissions (CO2) and other greenhouse gasses, could reduce climate change (IPCC, 2022) The EU has set multiple plans and targets to respond to the climate crisis.

The European Climate Pact is an initiative that seeks to bring together people, communities, and organisations within the EU with the aim of sharing and generating knowledge about climate change and developing and implementing solutions to the climate crisis. As such,

Co-funded by the European Union

the Pact commits to raising awareness on climate issues as well as supporting action towards climate change. The Pact focuses upon facilitating the development of green areas (mainly in cities), green transport, green buildings, and green skills (European Commission, 2022). Additionally, the EU has set the target of "reducing greenhouse gas emissions to at least 55% below 1990 levels by 2030" (European Commission, 2022), paving the way for realizing the target of becoming climate-neutral by 2050 – "an economy with net-zero greenhouse gas emissions" (European Council, 2019).

This vision is central to the European Green Deal and in accord with the objectives of the Paris Agreement. The Paris Agreement, also referred to as the Paris Accords or the Paris Climate Accords, is a legally binding international climate change agreement adopted under the United Nations Framework Convention on Climate Change (UNFCCC, 2022) in 2015 and formally ratified by the EU in 2016 (European Commission, 2022). The Paris Agreement (UNFCCC, 2022) sets a framework for all member states that aims to keep global warming "to well below 2°C above pre-industrial levels" while aiming to limit it to 1.5°C, "since this would significantly reduce risks and the impacts of climate change" (European Commission, 2022). In addition, member states have submitted national climate action plans and agreed to "strengthen societies' ability to deal with the impacts of climate change" as well as to provide support for developing countries to deal with these impacts (European Research Executive Agency, 2022). The agreement also addresses the need of preventing and minimizing loss and damage resulting from climate change impacts, as well as the need of developing early warning mechanisms, emergency preparedness and risk insurance (European Commission, 2022).

Co-funded by
the European Union

The European Commission (2019) introduced the European Green Deal in 2019 − officially approved in 2020 − which consists of a set of policy initiatives and strategies aiming to realize the targets set for 2030 and 2050. As such, the Deal focuses on how to transform the EU's economy to ensure a sustainable future. The objectives of the European Green Deal can be understood as having a twofold structure: 'Designing a set of deeply transformative policies' and 'Mainstreaming sustainability in all EU policies' (European Council, 2019).

Co-funded by the European Union

Citizen Science Projects for Climate Change: *Selected Examples*.

As part of its strategy of furthering research and innovation for tackling climate change, the EU has introduced Horizon Europe, a successor to Horizon 2020. Horizon Europe is a seven-year "funding program for research and innovation" that was launched in 2021, aimed at tackling climate change, achieving the UN's Sustainable Development Goals, and advancing EU's competitiveness and growth (European Commission, 2022). Numerous citizen science projects and initiatives aimed at tackling climate change have been funded through Horizon 2020. Some of these projects and initiatives are included here as an example of the possibilities of citizen science as a research and public engagement approach towards a common goal.

IMPETUS: Turning climate commitments into action

Impetus brings together 32 partners from nine European countries, including Greece and Italy, to address the lack of adaptation mechanisms that are in place for mitigating the impacts of climate change. The goal is to contribute to "Europe's climate adaptation strategy" (IMPETUS, 2022) for becoming "climate resilient by 2050" (European Commission, 2022).

The project's teams are testing potential solutions to local climate change impacts by:

- engaging with local communities,
- businesses,
- and policy makers.

This facilitates knowledge sharing between scientists, the impacted public and policymakers.

This process aims at developing a sense of initiative and ownership of adaptation strategies by locals and stakeholders. This large-scale project, both in terms of its geographic scale and the number of participants involved, has the potential of generating new knowledge on climate change and to spread that knowledge across the globe through local participation.

Co-funded by the European Union

DRYvER

The DRYvER project addresses the negative impacts of climate change on river networks. River networks provide essential resources to communities, such as food and water. Climate change and increased water use lead to the drying up of rivers and streams worldwide. This threatens the proper functioning of river networks (DRYvER , 2022).

Professional researchers and the public, come together to:

- examine the direct and indirect impacts of climate change on river networks,
- to develop new strategies to mitigate the negative effects
- and therefore, contribute towards the objectives of the Paris Agreement (DRYvER , 2022).

The public can participate by:

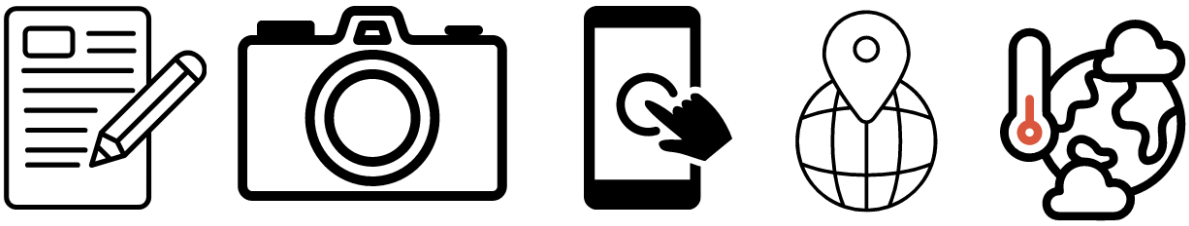
- downloading the “DRYRiVERS” mobile application or by visiting the web application.
- Participants are requested to survey and describe the hydrological conditions of watercourses around their current location.
- Take a photo of the conditions and share it with the team through the application. This creates a pinpointed world map displaying the geolocation of the spot, the photo taken, and the description of the conditions reported.

Participants from around the world are invited to take part in this project. This wider participation is beneficial to:

- the collection of widely dispersed data that can provide information on the relationship between climate change and the drying river networks
- citizen participation in environmental initiatives.

Co-funded by the European Union

LICCI: Local Indicators of Climate Change Impacts



The LICCI project seeks to collect insights from local people on their knowledge from their interactions with their local environments, to identify local impacts of climate change (LICCI, 2015). Through this project, “expert” researchers benefit from exploring new data sources on climate change that can also address climate change impacts that usually remain uninvestigated in natural scientific research. Specifically, those that concern the socio-economic well-being of people and communities.

Participants:

- record their perceptions of climate change impacts on for example, rainfall pattern changes, shrinking glaciers and crop failures (LICCI, 2015).

Observations on local climatic conditions are

- Logged and categorized in the free and open-source platform OpenTek.
- Images can also be uploaded.

Through this resource, participants globally are not only given the opportunity to engage in a scientific endeavor about climate change and enrich their knowledge on this topic by observing, investigating, sharing, and exchanging information on the ecological changes in their local environments but also on changes occurring at a global scale.

Co-funded by the European Union

The Benefits of Citizen Science for the Environment and Climate Action.

Over the past decade, citizen science has gained prominence as a tool for science and public engagement, especially in the ecological and environmental sciences (McKinley, et al., 2017) (Pocock, et al., 2018). Citizen science is beneficial as a method of scientific investigation, policy making, society and participant development (Kelly, et al., 2019).

In a recent study by marine citizen science coordinators (Kelly, et al., 2019) the synergy between citizen science and social license and the ways they work together to support conservation has been highlighted. Social license is the concept that reflects community views on the use and management of natural resources (Kelly, et al., 2019). Common key elements include engagement, connecting stakeholders, community representation, increasing learning and understanding, legitimacy of processes, cooperation and partnership, trust, and good stewardship (Kelly, et al., 2019, p. 4). Therefore, in the example of marine conservation, citizen science enhances social licenses and thus improves ocean literacy levels and marine citizenship (Kelly, et al., 2019).

Participation in Citizen Science projects:

- enhances the participants' sense of belonging to a common cause
- whilst it enables self-determination in actions, policies, and widespread phenomena.

It could be argued that, given the cost of policy implementation associated with a lack of social license on environmental issues, citizen science is essential in providing the grounds whereby environmental literacy, active citizenship and education for climate change coalition can occur in order to enhance the environmental literacy levels of communities and therefore, create interest and engagement with climate change issues and effects. The benefits of widespread public participation in citizen science projects will be elaborated in Chapter 2.

Co-funded by the European Union

CHAPTER 2

OPEN-UP CITIZEN SCIENCE

Co-funded by
the European Union

OPEN-UP CITIZEN SCIENCE

Widespread and Diverse Participation? The Current State of Citizen Science Projects

One of the main pillars of citizen science is the democratization of knowledge through the active engagement of the community in scientific research. The latter is no longer limited to the academic community. Even though citizens and scientists are being encouraged to work together throughout the overall scientific process, reality varies. The participation of disadvantaged or marginalized populations is not being adequately achieved (Pateman, et al., 2021). The paradox here is that although citizen science through the use of diverse technologies and tools can facilitate the development of a more inclusive citizen science community, the participation still refrains from being widespread and diverse.

The noticeable variety of citizen science projects around the globe (as showcased in Chapter 1), especially in the field of environmental protection and climate change, would imply that opportunities for participation are offered to anyone who might be interested in the objectives of citizen science projects. For example, for those who study extensively about the issues of biodiversity and pollution, the data collected in the framework of citizen science are important (Sherbinin, et al., 2021). Still though, the networks of citizen science projects are not

Co-funded by the European Union

realized to their fullest extent. There are many issues regarding the interconnection between citizen science projects and diverse populations (Pateman, et al., 2021), especially when it comes to the crucial matter of accessibility (Carr, 2021).

Citizen science can be the means towards a more inclusive society in general, where the urge to learn, research and experience brings individuals together within the common scope of environmental protection.

Who participates in CS projects?

The existing information regarding the global profile of the people who are more prone to engage in citizen science activities are very limited. Nevertheless, it has been observed that citizen scientists are not a homogenous group since each one of them has different motivations and reasons to participate in citizen science projects (Ceccaroni, et al., 2017).

Illustrated here are the most common reasons influencing people's participation in citizen science projects (Lampi, et al., 2021).

Co-funded by the European Union

Recent research on participation suggests that those engaged in citizen science projects or initiatives are typically white, middle-aged, and scientifically literate individuals (Blake, et al., 2020). Therefore, it is understood that there are societal and age groups which are not being included in citizen science projects (Pateman, et al., 2021). Although the reasons behind this discrepancy are variable, a dominant factor is the limited and selective dissemination of the participation opportunities.

Although a selective sample of citizen science initiatives appear to be successful in terms of inclusivity, the overall demographic data about citizen science participants are still demonstrating the engagement of empowered people rather than disenfranchised and marginalised groups (Lewenstein, 2022).

Engagement of marginalized populations in citizen science

According to Baah et.al. (Baah, et al., 2018) "…marginalised communities are those excluded from mainstream social, economic, educational, and/or cultural life. Examples of marginalized populations include, but are not limited to, groups excluded due to race, gender identity, sexual orientation, age, physical ability, language, and/or immigration status. Marginalization occurs due to unequal power relationships between social group".

Although widespread inclusion is not adequately achieved by citizen science currently, a handful of projects pave the way for the possibilities of inclusion of marginalized groups. An example would be the **Extreme Citizen Science (ECS) group** (UCL, 2016). This approach aims to connect

Co-funded by the European Union

citizen science initiatives with people who do not have access to this field because of educational or technical barriers (Smith, 2022).

A representative example of ECS is the **ECSAnVis** (UCL, 2016) project which was implemented by EU researchers in collaboration with the Baka (Bayaka) people of the Congo Basin, a Central African population with significant experience in forest life.

The aim of the project is to facilitate the participation of non-literate people and those with little or no understanding of technology in research procedures, such as the development of scientific questions and the collection of data (UCL, 2016). The product of the project is a software called “Sapelli” which gives non-literate people the ability to collect important information about their region (UCL, 2016). There is no doubt that indigenous communities are the most appropriate people in terms of protection of biodiversity. The traditional ecological knowledge that indigenous communities hold means that their contribution to scientific research can be significant. By facilitating the exchange of this knowledge, humanity can tackle and even prevent the loss of species through the tailored development

Co-funded by the European Union

of management plans. By overcoming linguistic and cultural barriers through the use of technology, collaboration with local populations can be achieved, thus enabling the transmission of otherwise inaccessible information.

We do have the means not only to observe the natural changes around us, but also to actively tackle them. What we need is to give voice to the ones who need to be heard.

Co-funded by the European Union

The Benefits of Widespread Public Participation for Climate Change Action.

The phenomenon of climate change is undoubtedly something that puts the future of our planet, and subsequently humanity, in great danger. Fostering widespread civic participation within the scope of dealing with climate change is one of the key actions that can be taken to minimize the risk.

What is public participation?

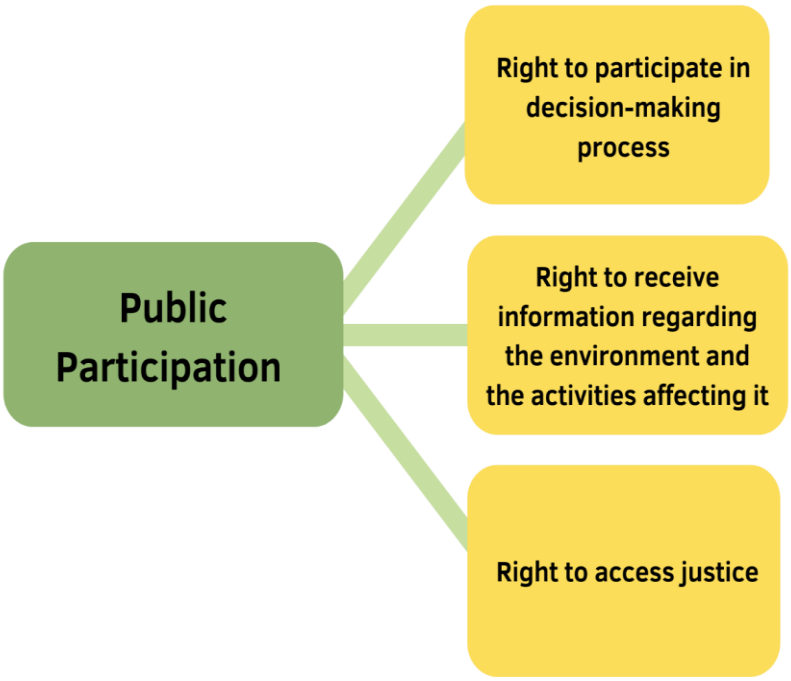
According to Hügel and Davies (2020) “While there is no singular universal definition, public participation is primarily viewed as an umbrella term incorporating various forms of interaction with people, from informing and listening through dialogue, debate, and analysis, to implementing jointly agreed solutions”.

What are the benefits of collective action against climate change?

As stated earlier, the contribution of community members in the conduction of research has a significant impact on the development of more tailored and more effective practices. Expanding the existing research format into a less centralized, more citizen led action, benefits science itself as the involvement of more actors raises the quantity as well as enhances the quality of collected data. In addition, as seen in the example of the ESCAnVIS project, taking part in citizen science initiatives can lead to the collection of information in both physical areas and research fields that are difficult to be reached.

Co-funded by the European Union

Public participation in climate action consists of the following components (European Commission, 2021):



Co-funded by the European Union

But is public participation important when it comes to decision makers?

Yes, it is!

- The democratic legitimacy of environmental decisions can be reinforced through active and public participation.
- Social conflicts which most of the times arise during the implementation of a project can be minimized, leading to a more effective decision making.
- It is a valuable means which gives voice to the community members regardless of their societal, economic, or educational status. Through public dialogue, all the concerns, the local values, as well as the expectations of the involved people are being brought up.
- Facilitates the production of more accurate results which can be applied in the framework of community and at the same time manage the natural resources in a more sustainable way (Chai, 2016).

An example of public participation

Greta Thunberg is an environmental activist who became widely known because of her protest outside the Swedish parliament in the year 2018 (Kraemer, 2021). Her aim was to put pressure on the governmental stakeholders to meet carbon emissions targets. Even though her action was small, its impact around the globe was tremendous.

Thousands of young people got inspired by her activism and organized their own actions. Few months after her strike, more than 20,000 students (from the UK to Japan) were touched by her message. A year later, she was nominated with the first of three Nobel Peace Prizes for climate activism (Kraemer, 2021). According to Thunberg, "You all come to us young people for hope. How dare you? You have stolen my dreams and my childhood with your empty words" (TIME, 2019). If it was not for the persistence of young people and

Co-funded by the European Union

the respective calls for expansion of the climate change initiatives, the management plans developed by decision makers would not be so ambitious as they seem to be now. Germany's Federal Constitutional Court decided recently that the state must develop more tailor-made and long-term plans to minimize greenhouse gasses emissions by 2050 (Cattino & Reckien, 2021).

The need to construct a solid public participation process is crucial. The goal here is to motivate every relevant actor, from the citizen that seeks to be involved in environmental adaptation practices to the corporate advocate. In case of a less organized public participation system, it is possible that the involved actors feel discouraged, thus resulting in undermining the exchange of ideas between communities and policy makers.

Benefits of public participation in climate change actions for the individual

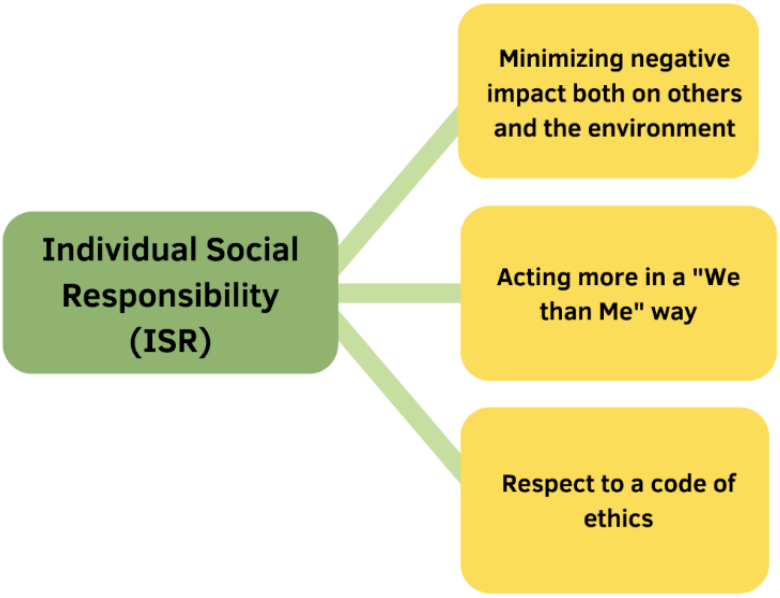
Public participation in actions within the scope of environmental protection fosters individual behavioral change. Community engagement can be characterized as a pathfinder leading to the acquisition of valuable competencies and skills.

Fostering Individual Social Responsibility (ISR)

Individual social responsibility describes a set of behaviors and/or actions that imply that the individual chooses to promote their individual interests without endangering what is good for the majority (Emmett, 2017). It is argued that citizen science projects for climate change hold the potential of increasing the individual's sense of responsibility by being actively engaged in providing collaborative solutions for a common cause. The concept of Individual Social Responsibility (Emmett, 2017) consists of the following elements:

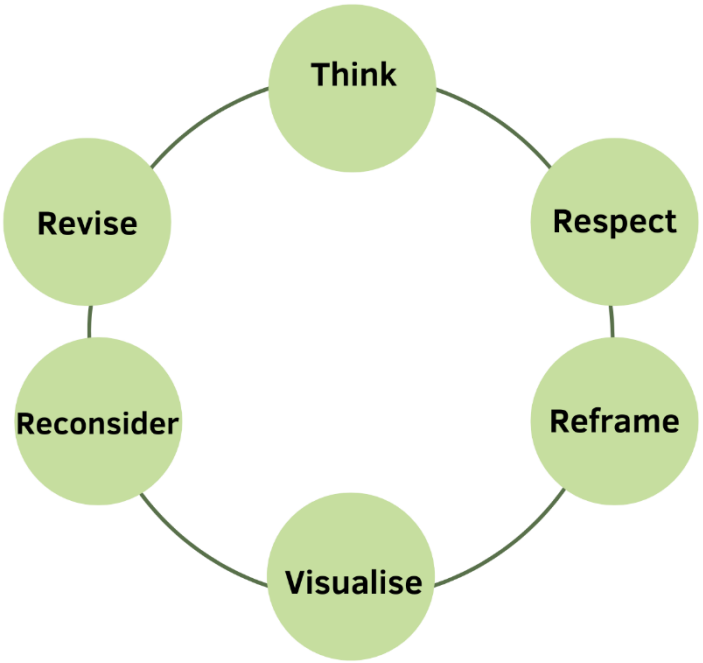
According to Emmett (2017), prior to (and perhaps during) public participation all individuals are to follow a process of self -reflection regarding the impact of their engagement.

Co-funded by the European Union



Increasing the sense of belongingness and social networking

The everyday requirements, the contemporary lifestyle, and the tendency to adopt more individualistic attitudes lead to social alienation. One of the remedies to this social problem can be civic engagement. In this respect, civic engagement in climate change actions can empower the development of local, citizen-based associations which can gradually create impact on both regional and national level.



Co-funded by the European Union

Building confidence and optimism among citizens

The American Psychological Association in 2017 (APA, 2022) defined the term eco-anxiety as "a chronic fear of environmental doom." Under the Diagnostic and Statistical Manual of Disorders eco or climate anxiety is not identified as a diagnosable mental health condition (APA, 2022). However, the presence of such a "chronic fear of environmental doom" can severely impact the mental health of those that experience it, including distress and trauma (APA, 2022). It can be argued that by participating in collective actions against climate change, especially in the form of research with the aim of creating solutions, presents the potential of developing confidence and optimism in the face of doom. Participants can experience and evaluate the impact of their initiatives.

Co-funded by the European Union

The Benefits for Disability and Social Participation

"Climate Crisis is Our Crisis Too"

The need to create inclusive societies becomes greater day by day. There is a tremendous number of minorities which are being excluded, consciously or not, from different types of social interaction. People with disabilities are excluded and marginalized from climate change action and decision making (IDA, 2021). Regrettably disability inclusive citizen science projects on climate change in the EU have not been identified in the research for the creation of this result. The establishment of disability inclusive citizen participatory activities that will enable disabled citizens to actively engage with their peers constitutes the pillar of an inclusive society.

At the international level, the International Disability Alliance (IDA, 2022), exists to promote the effective and full implementation of the Convention on the Rights of Persons with Disabilities (United Nations, 2022) worldwide. Its goal is the compliance with the United Nations' CRPD through the involvement of organizations representing persons with disabilities at regional, national, and international levels (IDA, 2022). The IDA firmly argues that "Climate Change is our Crisis too...We see climate mitigation plans being adopted without considering the consequences for persons with disabilities. That means that to climate decision-makers, we do not exist.' (IDA, 2021). In this respect, the IDA is working to ensure that the 2030 Agenda and its sustainable development goals are implemented in line with the UN CRPD (IDA, 2016). In particular, the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) in the Cancun Agreements, adopted at COP16 in 2010, identified persons with disabilities as one of the segments of the population whose human rights are severely affected by the impact of climate change (IDA, 2016). IDA is in the process of creating the Disability and Climate Action Caucus to unify and represent persons with disabilities in the United Nations Climate Action Conference. When even information on 'the climate crisis and ways to address it is not often provided in accessible

Co-funded by the European Union

formats such as sign language for deaf persons…" (IDA, 2021) then climate change action becomes inaccessible.

In this respect, it can be argued that the participation of people with disabilities in citizen science projects tackling climate change, can open- up avenues of meaningful engagement with policy decision making. This can lead to the enactment of disability-inclusive policies that enhance rather than undermine the human rights of persons with disabilities.

Some of the benefits occurring from the active engagement of people with disabilities in climate change actions can be divided into the following main sectors:

- **Education:** It is important to stress here that even though people with disabilities might want to engage with climate initiatives, the deficient dissemination of respective information and lack of accommodations hinders the whole process. This disabled the latter from receiving educational opportunities for growth. On the contrary, informed and properly educated citizens hold the capacity to understand technically difficult situations and come up with communitywide solutions. Citizens with a more advanced level of social understanding contribute to the development of better policy decisions, and therefore better social and environmental outcomes (Irvin & Stansbury, 2004).
- **Policy making:** Citizens that are active in terms of civic engagement issues can have a significant influence on key government decision makers. In this context, disabled participants would not only convey their viewpoint on climate change actions but would also gain an important spot in the public eye. An illustrating example of the practice would be the citizen advisory boards allowing DHH people to meet face to face with decision-makers (Irvin & Stansbury, 2004).
- **Personal development:** There is no doubt that social participation has a valuable impact on every aspect of personal growth. Through respective actions, people can gain the opportunity to investigate their interests and work collaboratively within

Co-funded by the European Union

the same scope. The feeling of belonging to a wider group can generate a series of further actions and motivate people to act in a novel way. Citizens are stronger when connected.

How to include more diverse populations is citizen science projects

The engagement of more diverse populations in citizen science projects, requires those designing them to re-consider the aims of their projects (Pateman, et al., 2021). For example, recent research studies on the manner by which citizen science can be made inclusive to disabled participants (Howlett, et al., 2021) highlight not only the beneficial elements experienced by the participants but the mechanisms that can be taken in order to widen diversity in participation (Carr, 2021). Some of those key aspects that must be considered when inclusion is a priority are summarised below.

A recent study at Queensland University of Technology emphasised the benefit of elevating participants to the status of co-creator or co-designer in citizen science projects (Howlett, et al., 2021). When this is enabled, differential needs and accommodations are communicated by the community for the community (Yanay-Ventura, 2019). Further, the creation of online accessible applications collecting the data gathered by participants can address any issues of institutionalized ableism, issues of mobility and covid 19 imposed restrictions (Yanay-Ventura, 2019). Other examples of mechanisms for widening diversity are targeting participants already embedded in communities and providing opportunities of involvement in different types of tasks with varying levels of time and skills needed (Pateman, et al., 2021).

Co-funded by the European Union

Other Considerations

- Overcoming potential language and communication barriers by translating all material from the predominant English language to many different languages and alternative forms of communication.
- Maintaining the interest of the participants by including them in all stages of the project and designing projects with the participant interests in mind.
- Including participants in decision-making procedures by elevating them to the status of co-designer or co-creator whenever possible.
- Using technology as an inclusive tool by placing extra focus on accessibility elements and ways to reach those with less digital skills and expertise.
- Maintaining trust to citizen science projects by establishing transparency throughout the whole lifecycle of the project (Lewenstein, 2022).

Co-funded by the European Union

CHAPTER 3

CITIZEN SCIENCE AND THE DEAF AND HARD OF HEARING

Co-funded by
the European Union

CITIZEN SCIENCE AND THE DEAF AND HARD OF HEARING

The Benefits of Participation in Citizen Science for the Deaf and Hard of Hearing

The Deaf and Hard of Hearing community is one of the many groups that are being marginalized. The establishment of citizen participatory activities which will give the DHH people the ability to encounter with their peers, constitutes the pillar of an inclusive society. Some of the benefits occurring from the active engagement of the DHH in citizen science are described in the following section.

Active Citizenship

According to the (EucA, 2016) “active citizenship means people getting involved in their communities and democracy at all levels from local to national and global. An active citizen promotes the quality of life in a

Co-funded by the European Union

community through both political and non-political processes, developing a combination of knowledge, skills, values and motivation to work to make a difference in the society". Unfortunately, this civic action is not sufficiently taken up by the d/Deaf public, due to lack of access and knowledge on civic matters. The CitSci4All project argues that the participation of deaf adults in citizen science can enable their involvement and commitment to environmental protection.

In fact, Dr Angeletaki (2022), one of the citizen science experts interviewed, stated that "citizen science is an example of how citizens can engage in meaningful climate action with the support of the scientific community. Through citizen science, participants can experience the effects of climate change and feel eager to take climate action in their communities…This leads to better informed citizens and so to an increase in their social inclusion and participation in their communities." Given that the d/Deaf communities are strongly knit communities, networked with local, national and international Deaf association, the participation of one d/Deaf community in a citizen science project could mean the dissemination of this method to others and the subsequent inclusion of many.

Building more inclusive societies

As indicated in Chapter 2, widespread and inclusive participation in citizen science projects is needed. It should not be limited to non-disabled people. People with disabilities are fully-fledged citizens who can and have a right to choose their level of engagement with and contribution to far reaching social and environmental causes through citizen science initiatives. In the context of a more inclusive society, and in application of Article 9 of the United Nations Convention on the Rights of Persons with Disabilities (United Nations, 2022), which calls on states to combat all forms of discrimination, the involvement of people with hearing impairments in citizen science projects, can enable the development of non-discriminatory societies. According to Article 9, the appropriate measures for inclusion are to be taken, an example being to "promote access for persons with disabilities to new information and communication technologies and systems …" (United Nations, 2022). By

Co-funded by the European Union

using technology and bottoms-up activities, it is possible for people with disabilities to participate in Citizen Science and experience active citizenship. Such participation can enhance their interest in science, citizenship, and ecology. These three topics are essential to build a new society and fight against climate change. This could be a starting point for people with disabilities to fully experience and participate in challenges together with many other communities.

Empowerment and inclusiveness

Citizen science projects, crafted with inclusion in mind, hold the potential of empowering disabled and other marginalized communities. An array of studies indicated the significance of volunteering by disabled and marginalized communities in creating a sense of belonging and giving back to society, as well as, increasing social interaction skills, mental health well-being and empowerment (Yanay-Ventura , 2019) (Wicki & Meier , 2016). As such, the d/Deaf community, enabled by educators, trainers, citizen science “experts'' and other professionals, can be empowered to participate and engage in civic causes more actively. Such empowerment and active engagement can be considered one of the cornerstones of inclusive societies.

Self-determination and inclusiveness

Another element of more inclusive societies is fostering individuals’ self-determination. According to UNAPEI (2022), being self-determined means acting as the main actor of one's life, in the dimensions that matter to one, without undue external influence. This implies having the possibility to multiply experiences in order to know one's desires, express oneself and assert oneself in one's choices, learn to evaluate the consequences of one's decisions and to assume them and

Co-funded by the European Union

dare to take risks in order to learn from mistakes. The self-determination approach is an ethical position, but above all a principle of support, a lever so that people with disabilities can live with and among others.

Therefore, citizen science projects by providing opportunities and choices in the level and manner of involvement of d/Deaf participants, can support and promote self-determination. DHH communities can choose what type of project they want to be part of according to their individual and collective interests and preferences. In this setting the scientific community and citizen science "experts" by reaching out to d/Deaf communities directly can make sure that projects are drafted with inclusive and adapted methodologies in mind, but also provide choices based on the communities' interests and preferences.

Educational benefits

Given that d/Deaf adults are rarely involved in environmental actions, their involvement in such research causes, will provide opportunities with educational benefits. According to Angeletaki (2022) "….I think citizen science has the potential to upskill citizens through the use of grassroots and bottom-up activities and the use of technology". They will be able to acquire vocabulary and scientific concepts that they will then be able to use or apply in other causes. Through a firsthand experience with grassroots and bottom-up activities, they will be enabled to become creators of future or other actions. Equally by engaging with an array of digital tools created for the purposes of a project, the participant is enabled to upskill their ict skills. This knowledge will also have a direct impact on their lifestyles as they will become living ecological role models able to impact others. They will thus be made aware of this cause and will be able to transmit to their peers their commitment and the need to protect the environment.

In this respect, citizen science can create the grounds whereby active citizenship, empowerment and self-determination can be fostered, all leading to the development of more inclusive societies. Equally by engaging with scientific tasks, knowledge and material, the d/Deaf community is given the opportunity to increase its levels of awareness and

Co-funded by the European Union

knowledge on issues of scientific, environmental, and social significance. Information on those issues is not readily available in a society that overwhelmingly favors audio-centric forms of communication and knowledge exchange.

The Reciprocal Benefit of Inclusion: Facilitating Social Cohesion by Breaking Down Communication Barriers.

The alternative methods of communication used by people with hearing impairments can be an obstacle to collaboration on projects involving hearing people in a predominantly audio -centric world. Indeed, few people in Europe are trained to use sign language (ECML, 2022). It is estimated that there are 750,000 Deaf people using Sign languages in the European Union (ECML, 2022). On average, the share of d/Deaf people using Sign language is 0.1% of the overall population in each country (ECML, 2022). However, oral communication abilities are not a prerequisite of participation and engagement in citizen science projects. The participatory methods and skills needed (or developed) through citizen science projects can facilitate the co-active involvement of both d/Deaf and hearing populations in projects. Such cooperation and co-participation is believed to break down communication barriers.

As explained in Chapter 1, observation, recording and reporting of data are the most common tasks requested of participants. For example, environmental projects usually request participants to notice differences and/or changes to their immediate environment (birds, plants, trees, or animals). Observational skills are highly developed by d/Deaf people, given that the nature of their hearing disability requires a stronger reliance on visual input. These observations are most often recorded in an online platform or in a textual format. Therefore, the lack of reliance on the predominant oral communication models used by hearing people, enables the active engagement of the d/Deaf community in citizen science projects. Therefore, in those citizen science projects where online communication between

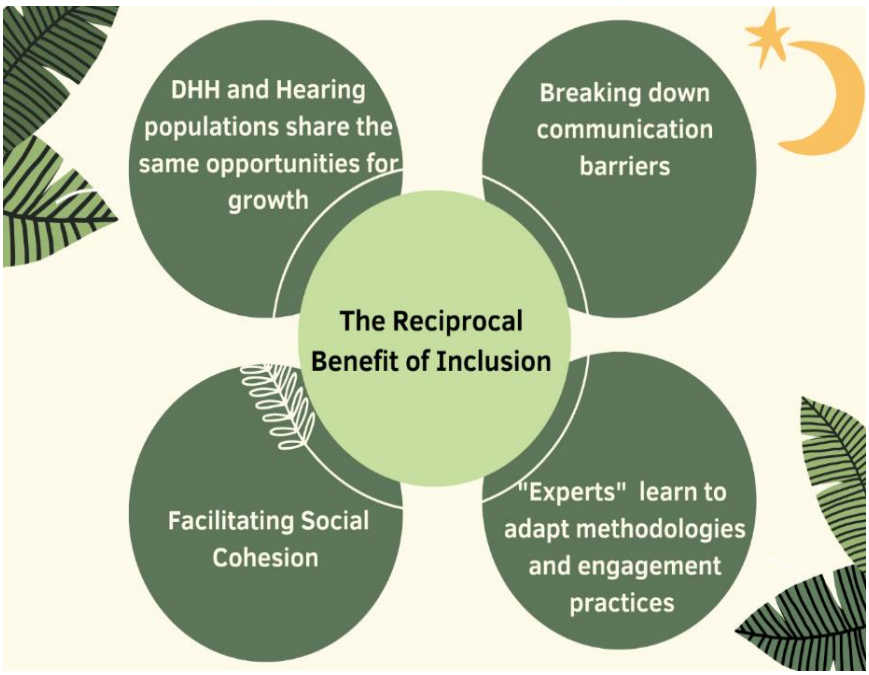
Co-funded by the European Union

participants is facilitated, a common space between d/Deaf and hearing communities is created.

By participating in a citizen science project, anyone can feel the emotion to be part of a dedicated group of people, and to act for climate change. For DHH persons, this feeling can be important, as they are not always included in social action as everyone else. Citizen science presents an opportunity for the DHH community to start its journey into social action with the hearing community. Knowledge on scientific research methods, practices and on environmental issues will naturally increase alongside their role as agents of change in their communities and their feeling of belonging in collective action for climate change. This enhanced sense of belonging to a larger (or even global) community of action for a common cause can increase the potential for future involvement in more actions and future projects focusing on climatic issues or other social actions.

Equally, through the process of co-creation and co-design of citizen science projects, by both hearing and d/Deaf people, “experts” and “non-experts” in the field, communication barriers are challenged, and social cohesion can be achieved. Citizen science “experts” will learn to adapt their material and communication methods to be suitable and engaging for their d/Deaf participants, whilst the latter are presented with new opportunities for participation and involvement.

The reciprocal benefit of inclusion lies in the realization that by overcoming communication barriers new opportunities for growth and development are



Co-funded by the European Union

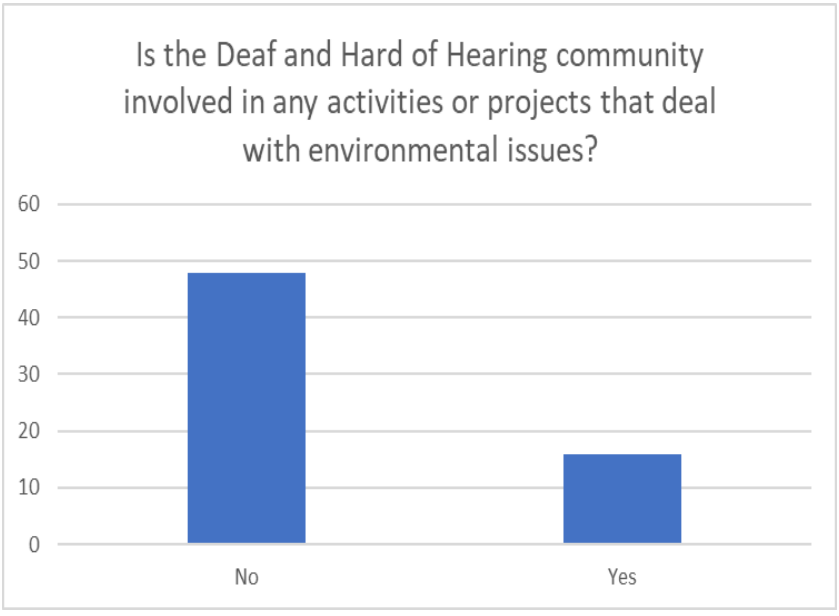
presented to different communities, to the “expert’ and “non-expert”, to the d/Deaf and the hearing alike. In this respect, by breaking down communication barriers, communities such as the DHH that are traditionally excluded from active participation in environmental action are actively involved whilst the scientific and global community can benefit from that participation. What can be achieved is a more inclusive society that favors a more active fight against global warming by raising the awareness of both the d/Deaf and hearing communities.

Co-funded by
the European Union

Ways to Facilitate Inclusion for Deaf and Hard of Hearing Adults in Citizen Science Projects.

The Methodology of The CitSci4All project: initial consultations and results.

The CitSci4All project's goal is to include the d/Deaf community in one of the greatest challenges of our time, the fight against climate change by crafting d/Deaf inclusive approaches to citizen science projects and initiatives. For this reason, the CitSci4All consortium, through expert consultations, online surveys, and interviews with both DHH trainers and citizen science experts, gathered insights and guidance on d/Deaf inclusion in citizen science projects for climate change. To develop a guide with the intention of including the D/deaf community, it is necessary to interview members of this community. Otherwise, one runs the risk of speaking on behalf of a group of people without knowing their real needs, knowledge, and background information on the subject. These consultations and the results of the survey were instrumental in the formulation of the CitSci4All project and are therefore briefly outlined in this section.

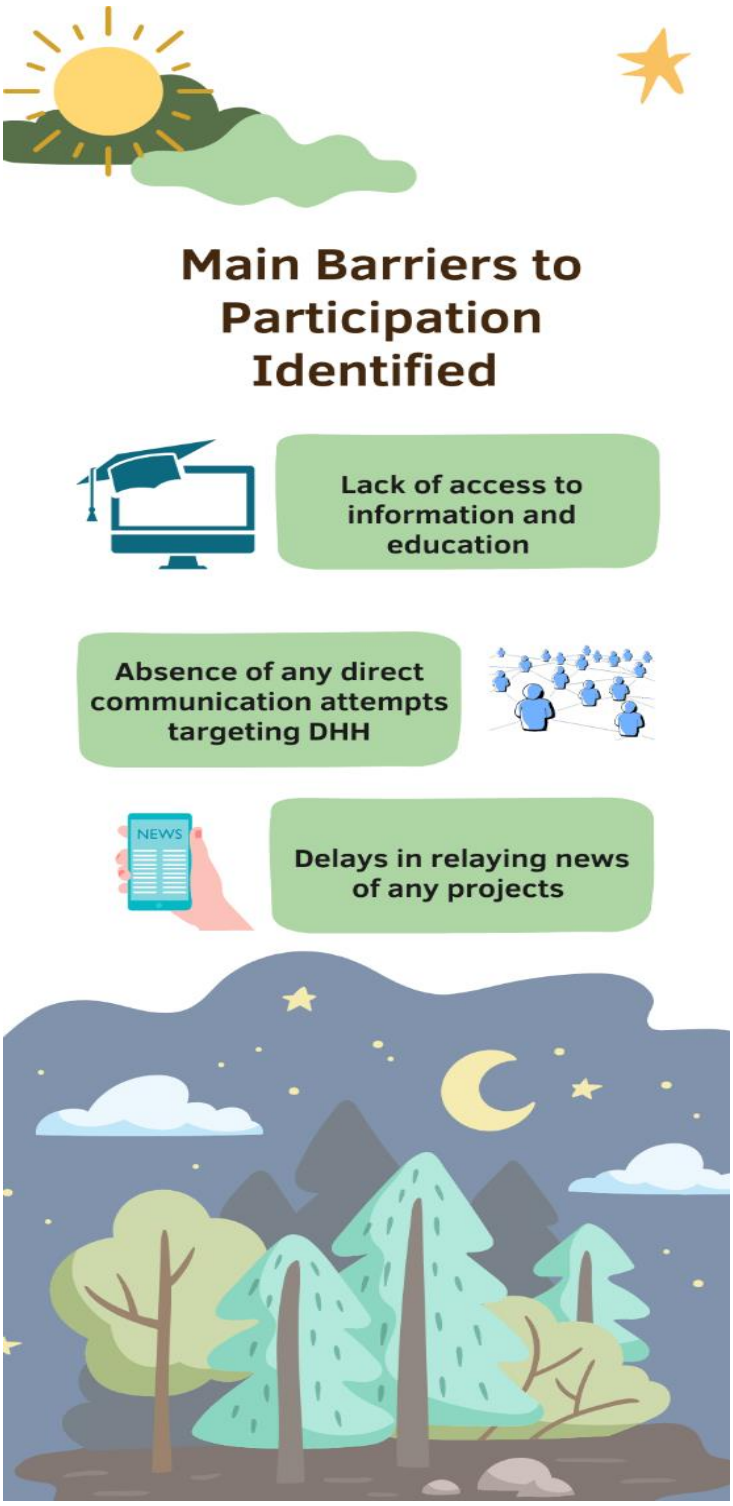


In total, 64 DHH trainers responded to the online surveys disseminated in the national contexts of Cyprus, Italy, France and Greece. In addition, nine DHH trainers were selected to provide expert consultation and guidance on the d/Deaf community's manner of

Co-funded by the European Union

involvement with environmental causes. Finally, nine citizen science experts participated in the interview phase of this research project providing their expertise on the presence or lack thereof of inclusive citizen science projects and guidance on the manner by which inclusion can be facilitated.

Both survey results and interview responses indicated that DHH adults are overwhelmingly not aware of any citizen science projects and its benefits for their scientific and social inclusion. Equally, survey results indicated that DHH adults are at large not involved in any activities or projects concerning environmental issues, whether it Is citizen science projects or other.



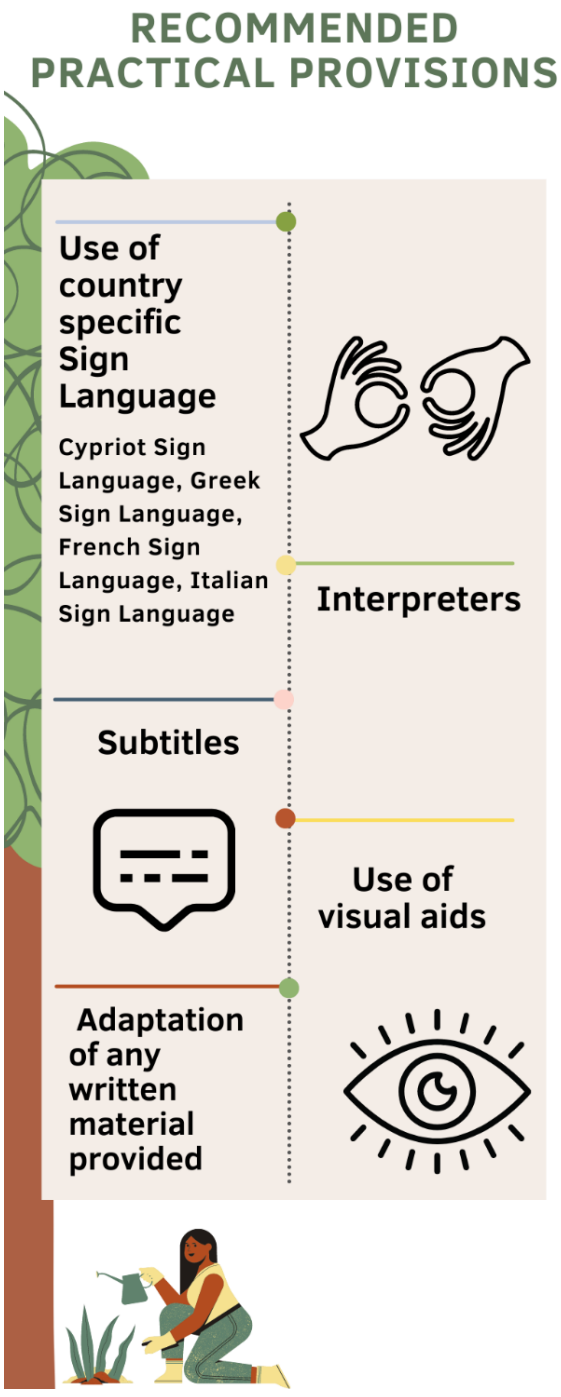
The main contributors to a lack of participation or barriers to inclusion in environmental initiatives were identified as a lack of access to information and education, absence of any direct communication attempts targeting DHH adults and delays in relaying the news on any citizen science or environmental project. This confirms and reinforces the idea of developing

Co-funded by the European Union

a project that focuses on raising awareness on the possibilities of scientific inclusion of the DHH in matters of environmental significance and enables their active citizenship. The ways of breaking down these barriers and creating DHH inclusive citizen science projects are elaborated below.

Practical Provisions: Interpreters, visual accommodations, and access to information

From the interviews conducted in the initial stage of the CitSci4All project, three fundamental tools for full access to information emerged. That is the presence of the interpreter, adequate visual accommodation and full access to information using the appropriate vocabulary. The following critical issues in accessing information on training or other related events were reported:



- Difficulties in understanding specialised vocabulary.
- Information about a project or event never reaches the d/Deaf community or they are informed too late and are therefore unable to arrange for an interpreter to be present and offer support.

Interpreters

The right to access to information Is enshrined in the UN Convention under Article 21 (2022). Citizen science projects that need to

Co-funded by the European Union

communicate information in any other way other than a written format need to include sign language interpreters.

One of the better-known interpreter associations is the World Association of Sign Language Interpreters (WASLI, 2021). WASLI promotes the profession of sign language interpreters worldwide. The World Federation of the Deaf (WFD, 2016) and WASLI work closely together for the benefit of deaf people, sign language users and the sign language interpreting profession.

Visuals Accommodations

The preferred methods of communication of d/Deaf people are methods that are heavily reliant on visual elements and transmission of information. It is therefore essential, when learning new concepts and information, to make use of visual material, such as photos, pictures, infographics, and videos, that can exemplify the content. For example, Giorda T. (2022) one of the DHH trainers that participated in the interview phase of the CitSci4All project in the national context of Italy, highlighted the usefulness of an experiential approach to learning and engaging with new issues of social significance in the d/Deaf community. For instance, photos or a trip to a dried-up lake to show the effects of climate change can be excellent communication and training tools for d/Deaf people.

This is an example of how the appearance of a lake can change due to climate change:

BEFORE

AFTER

Co-funded by the European Union

In addition, if there are training videos as visual materials, it is essential to use subtitles or a sign language interpreter.

- Examples of educational videos in sign language (in this case American Sign Language), with an interpreter, visual aids, and subtitles on the subject of climate change can be found in the digital curriculum designed by Wickman J. (2020) entitled "ASL STEM Dictionary".

Descriptions of Terms used in Citizen Science Projects in Sign Languages

The "ASL STEM Dictionary" is a rare example of a lexicon introducing and explaining terms about the environment and climate change in Sign Language. In fact, one of the DHH trainers in the national context of Cyprus that was approached for an interview, explained that one of the reasons that DHH adult participation in environmental initiatives is extremely rare is because of the incomplete access to information and awareness about climate change issues. The latter explained that the hearing community will most probably regularly come across terminology on climate change and the environment. This enables them to get gradually accustomed to those meanings. Contrary to the hearing population, DHH adults are not afforded the same regular exposure to information and terminology regarding climate change, the environment or citizen science in general.

For this reason, the CitSci4All project argues in favor of the creation of a glossary of terms in both textual and sign language video formats, describing and explaining those key topics and concepts that are essential in any given citizen science project that

Co-funded by the European Union

aims to be inclusive towards the d/Deaf community. For example, in the context of the CitSci4All project, the consortium will provide sign language videos in all the national contexts of the partnership, introducing and explaining those key concepts related to climate change. This will be made available in the CitSci4All Toolkit (Project Result 2); a tool aimed at enabling the d/Deaf community to participate in the training activities and/or citizen science projects that are to be implemented as part of Project Result 3.

ASK: "Nothing About Us Without Us"

Dr Carr (2022), one of the specialist citizen scientists consulted for the creation of this guide, stated that if inclusion and engagement is a priority in citizen science projects then five key points need to be considered and implemented.

- ASK the community and/or the participant what makes a project exclusive and how it can be made more inclusive.
- Provide better scaffolding for participants on Citizen Science platforms. "When citizen science is done well, it should provide scaffolding support for people coming to it with all different levels of knowledge."
- Offer capacity building at all levels of the research process.
- Engage with the communities from the beginning of the research process until the end and let them decide their level of engagement.
- Allow citizen science to shift its focus so that it is less focused on the production of new "scientific" knowledge, but instead allows for these communities to conduct citizen science projects that have a direct impact on them and their community.

In this respect, DHH inclusive citizen science projects on climate change need to inform the community on climate change concerns and allow their interest to inform their participation and co-design of projects. Similarly, the collaboration of Deaf associations and clubs, as well as d/Deaf communities in the creation of such projects can ensure community accessibility. These elements are elaborated further below.

Co-funded by the European Union

Identify climate change concerns and interests

When raising awareness on the issues of climate change it is important to identify specific examples related to this issue that are relevant to the community. Observing together the change of a known place allows us to understand the extent of climate change, its consequences in our daily lives and helps us to face it together by finding solutions. Starting with concrete examples, we can analyse what the interests and willingness to participate in the fight against climate change are.

Some examples of concerns raised during the interviews were:

- Increase in the planet's temperature
- the melting of glaciers and the drying up of lakes
- Increase in fires

For example, as indicated in Chapter 1 of this guide, in recent years we have observed a sharp increase in summer fires across Europe. In the Mediterranean area we have observed increasingly high temperatures with long periods of drought that have created favorable conditions for the spread of fires and forest fires. The European Commission has proposed the new European Forestry Strategy 2030 (European Commission, 2021). Its aim is to intensify forest fire prevention and promote better climate resilience.

Co-funded by the European Union

Co-design the materials with DHH community

By co-designing citizen science projects on climate change, we essentially include the d/Deaf community in all stages of the research project, from its inception to its completion. Both the topic of the project and the materials required, or the activities included for the implementation of the latter, are to be drafted from the perspective of the d/Deaf community. For example, visual materials capable of explicating specific vocabulary in a simple and direct manner are essential for successful implementation. Such material can be text with pictures, maps and glossaries. They should always be used in such a way that everyone has access to the same information, simply through different communication channels.

*C*ollaborate with Deaf associations and local deaf clubs/centers

Dialogue and cooperation with local and national Deaf associations and centers is of paramount importance. Throughout the research stages for this guide, it was made evident that the d/Deaf community has a strong solidarity network. Their shared participation in common activities and social events, highlights the necessity of closely collaborating with Deaf association and involving the community directly, if inclusion in citizen science projects is to be achieved.

One of the oldest international organizations of people with disabilities in the world is the World Federation of the Deaf (WFD, 2016) that was founded in Rome on 23 September 1951. WFD recognizes that deaf people face obstacles to full accessibility, equal human

Co-funded by the European Union

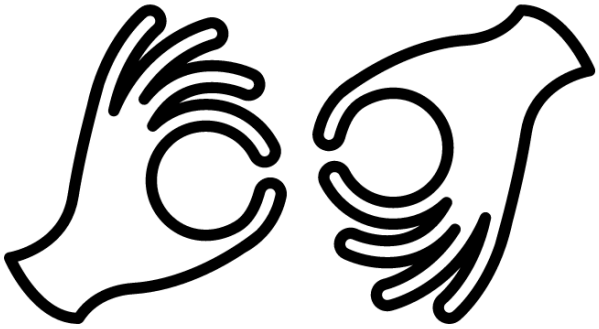
rights and participation in political decisions that affect them globally. To date 125 countries in five continents are represented within this organization.

Its partners include the European Union of the Deaf B (EUD, 2022), a non-profit and non-governmental organisation whose members include national d/Deaf associations throughout Europe. Their vision is for D/deaf people throughout Europe to enjoy equality in public and private aspects of life (EUD, 2022).

Co-funded by the European Union

DEAF ASSOCIATIONS

Examples and Links



HIPEN

European Network for Professionals working with People with Hearing Impairments

IRSAM

French association supporting people with sensory impairments and partner of the CitSci4All project

IST

Turin Institute for the Deaf in Italy and partner of the CitSci4All project

SCHOOL FOR THE DEAF

School for the Deaf in Cyprus

HELLENIC FEDERATION OF THE DEAF

Federation of the Deaf in Greece

The associations listed above are included here as examples of Deaf associations and centers in Europe or in the national context of the CitSci4All consortium. Other than IRSAM and IST, that are the specialist CitSci4All partners, this project and its' deliverable has no direct affiliation with the rest.

Co-funded by the European Union

Where do we go from here?

As stated throughout this Guide, disability-inclusive citizen science projects on climate change, catering to the needs of DHH adults are lacking from the pool of available OF citizen science projects currently underway in the European Union. Equally, information on the existence of any citizen science projects and the present opportunities for participation are rarely (or never) communicated to the d/Deaf community.

Information should be made available to the d/Deaf community. Available resources and examples of some of the popular EU platforms offering information on various citizen science projects and ways to participate are included here. These could serve as starting points for DHH Trainers in their efforts to make the d/Deaf community aware of citizen science projects.

Find Citizen Science Projects

- EU-citizen.science
- European Citizen Science Association
- Science Ensemble
- Scienza Collaborativa

Co-funded by the European Union

Further, it is the recommendation of this consortium that inclusiveness should be added to the principles of Citizen Science. The “expert” citizen science community needs to elaborate on their efforts for inclusive accommodations and adaptations in citizen science projects. This is a sentiment that is shared among the majority of citizen science experts interviewed as part of this project result. An example could be the discussion at interview with Dr Brounéus (2022), that is that the eu.citizen.science platform can add to their filtering in resources in order to direct the visitor to those resources and projects that are inclusive of people with disabilities.

What Next?

What has been evident throughout the research stages for this guide is that there exists a need for targeted knowledge exchange for both DHH adults and researchers as a precondition for the successful implementation of and engagement with citizen science projects. This guide is created to raise awareness as to the benefits of participation in citizen science projects for DHH adults. In the next part of the CitSci4All project a "Customized Citizen Science Toolkit for DHH Trainers" will be developed, in order to offer a methodology to plan, contribute and build citizen science projects on climate change for DHH adults. The use of digital learning modules, inclusive multimedia resources. E-learning videos on all sign languages of the consortium, interactive presentation, infographics, and case studies following the inclusive premises outlined above, is believed to enable DHH adults in implementing citizen science projects.

Co-funded by the European Union

CONCLUSION

Citizen science has proved instrumental in the fight against climate change. It has gained EU-wide recognition resulting in a myriad of projects on environmental sciences being practiced at a community level, placed in schools, and extending as far and wide throughout the globe through digital engagement (see Chapter 1). This scientific research method and practice has been shown to positively affect scientific investigation, policy making, society and participant development (Kelly, et.al. 2019). Through public engagement, “expert” citizen scientists are enabled to collect information on a global phenomenon and reach into habitants and locations that would otherwise be non-feasible given the cost of implementation and human resources. Equally, participants are upskilled in an array of digital skills, research methods and practices whilst they enhance their environmental literacy levels and thereby create interest and engagement with climate change issues and solutions. Knowledge that can drive the individual and the community towards more active levels of public participation in the community and at a policy level.

It is argued that given the benefits of widespread public participation in citizen science for the scientific community and for climate change causes, the current absence of accessible, adapted and disability-inclusive projects, hinders the global effort against climate causes. Although people with disabilities are disproportionately affected by the effects of climate change and action, they are excluded and marginalized from decision making (IDA, 2021). The absence of material in different sign languages communicating the effects and actions on climate change to the DHH population, essentially disables them from participation in a common dialogue on the solutions. Provided adapted methodologies and inclusive and accessible tools are created, citizen science projects present the opportunity for the scientific and social inclusion of people with disabilities in citizen science projects for climate action. As showcased in Chapter 3, when accommodated with the provision of adapted informational material in sign-language with a focus on visual representations, as well as when needed sign-language interpreters and subtitles, DHH adults can gain access to information that is otherwise not accessible. Equally, inclusive projects that provide

Co-funded by the European Union

scaffolding opportunities for participant engagement and capacity building opportunities at all levels of the research project, as well as projects that elevate the DHH population to the status of the co-creator and co-designer, enable self-determination in actions and policies. This can lead to hearing impairment inclusive policies that enhance the rights of the community in representation and participation in climate action discussion and solution.

Of importance is the reciprocal benefit of including the DHH population in citizen science projects. Bringing two communities together, the “expert” and “non-expert” in a predominantly audio-centric world, presents opportunities of breaking down communication barriers to find new opportunities for growth and development for all. The CitSci4All consortium is hopeful that this guide will serve as the starting point for awareness raising on climate change issues and the benefits of citizen science, as well as further discussion on the manner of engagement and inclusive methodologies and tools. Such discussion will undoubtedly spearhead the social and scientific inclusion of DHH adults in citizen science projects.

Co-funded by
the European Union

References

Angeletaki, A., 2022. *CitSci4All: Interview on Citizen Science and the participation of the Deaf and Hard of Hearing.* [Interview] (March 2022).

APA, 2022. *American Psychological Association.* [Online]
Available at: https://www.apa.org/
[Accessed 30 May 2022].

Baah, O. B., Teitelman, A. M. & Riegel, B., 2018. Marginalization: Conceptualising patient vulnerabilities in the framework of social determinants of health - An integrative view.. *Nurs Inq,* 26(1), pp. 1-26.

BBC , 2021. *What is climate change? A very simple gude..* [Online]
Available at: https://www.bbc.com/news/science-environment-24021772#:~:text=Climate%20is%20the%20average%20weather,their%20homes%2C%20factories%20and%20transport.

Blake, C., Rhanor, A. & Pajic, C., 2020. The Demographics of Cititizen Science Participation and its Implication for Data Quality and Environmental Justice. *Citizen Science: Theory and Practice,* 5(1), pp. 1-10.

Bonney, R. et al., 2009. Citizen Science: A Developing Tool for Expanding Science Knowledge and Scientific Literacy. *BioScience,* 59(11), pp. 977 - 984.

Brounéus, F., 2022. *CitSci4All: Interview on Citizen Science and the participation of the Deaf and Hard of Hearing* [Interview] (March 2022).

Buis, A., 2019. *A Degree of Concern: Why Global Temperatures Matter: NASA's Global Cimate Change Website.* [Online]
Available at: https://climate.nasa.gov/news/2865/a-degree-of-concern-why-global-temperatures-matter/
[Accessed 13 May 2022].

Carr, J., 2021. *Can an Inclusive Approach Meaningfully Engage People with Learning Disabilities? Exploring Capacity Building for Citizen Science.* PhD Thesis ed. London: The Open University.

Carr, J., 2022. *CitSci4All: Interview on Citizen Science and the participation of the Deaf and Hard of Hearing.* [Interview] (March 2022).

Cattino, M. & Reckien, D., 2021. Does pubic participation lead to more ambitious and transformative local climate change planning?. *Current Oppinion in Environmental Sustainability,* Volume 52, pp. 100-110.

Co-funded by the European Union

Ceccaroni, L., Bowser, A. & Brenton, P., 2017. Civic Education and Citizen Science: Definitions, Categories, Knowledge Representation. In: *Analyzing the Role of Citizen Science in Modern Research..* Hershey: IDI Global, pp. 1-23.

Center for Climate Adaptation , 2022. *Climate Change Post.* [Online]
Available at: https://www.climatechangepost.com/italy/climate-change/

CFF, 2021. *Crops For the Future.* [Online]
Available at: https://cropsforthefutureuk.org/
[Accessed 13 May 2022].

Chai, T., 2016. *The Importance of Public Participation.* [Online]
Available at: https://ejsclinic.info.yorku.ca/2016/04/the-importance-of-public-participation/
[Accessed 30 May 2022].

Citizen Science Centre in Zurich, 2021. *Practicing Citzien Science in Zurich. Handbook ,* Zurich : Citizen Science Centre in Zurich.

Costello, R., 2017. A new century of (citizen) science. *Informal Learning Review,* 142(1), pp. 18-21.

Council of the EU , 2021 . *Council adopts European climate law.* [Online]
Available at: https://www.consilium.europa.eu/en/press/press-releases/2021/06/28/council-adopts-european-climate-law/

Damalas, D. et al., 2015. "Once upon a time in the Mediterannean" Long Term Trends of Mediterrannean Fisheries Resources Based on Fishers' Traditional Ecological Knowledge. *Plos One ,* 1(17), pp. 1-22.

DRYvER , 2022. *DRYvER: Drying Rivers and Climate Change.* [Online]
Available at: https://www.dryver.eu/
[Accessed 13 May 2022].

ECML, 2022. *European Centre for Modern Languages of the Council of Europe.* [Online]
Available at: https://www.coe.int/en/web/education/ecml
[Accessed 20 June 2022].

ECSA, 2020. *ECSA's characteristics of citizen science.,* s.l.: ESCA.

ECSA, 2021. *ECSA 10 Principles of Citizen Science,* London: OSFHOME.

Emmett, S., 2017. *Individual Social Responsibility.* [Online]
Available at: https://procurementandsupply.com/2017/02/individual-social-responsibility/
[Accessed 30 May 2022].

EMSC, 2020. *CSEM European-Mediterranean Seismological Center.* [Online]
Available at: https://www.emsc-csem.org/service/application/
[Accessed 13 mAY 2022].

Co-funded by the European Union

Encyclopaedia Britannica, 2022. *The Britannica Dictionary.* [Online]
Available at: https://www.britannica.com/dictionary/environment
[Accessed 30 05 2022].

EPA, 2021. *Environmental Protection Agency Network Interest Group in Citizen Science.* [Online]
Available at: https://epanet.eea.europa.eu/reports-letters/epa-network-interest-group-on-citizen-science/epa-network-interest-group-on-citizen-science
[Accessed 30 May 2022].

EPPO, 2014. *European and Mediterranean Plant Protection Organisation.* [Online]
Available at: https://www.eppo.int/ACTIVITIES/invasive_alien_plants/eu_prioritization
[Accessed 13 May 2022].

ESCA, 2022. *European Citizen Science Association, What is Citizen Science?.* [Online]
Available at: https://ecsa.citizen-science.net/
[Accessed 16 June 2022].

EucA, 2016. *Active Citizenship: Citizens make the future of the country. But what makes active citizens?.* [Online]
Available at: https://www.euca.eu/activecitizenship
[Accessed 20 June 2022].

EU-Citizen.Science, 2022. *eu-citizen.science.* [Online]
Available at: https://eu-citizen.science/
[Accessed 19 April 2022].

EUD, 2022. *European Union of the Deaf.* [Online]
Available at: https://www.eud.eu/
[Accessed 23 June 2022].

European Commission , 2019. *Open Science.* [Online]
Available at: https://ec.europa.eu/info/research-and-innovation/strategy/strategy-2020-2024/our-digital-future/open-science_en
[Accessed 13 May 2022].

European Commission, 2019. *Communication from the Comission to the EU Parliament, the EU Council, the EU Economic and Social Commitee and the Committee of the Regions; The European Green Deal ,* Brussels: European Commission .

European Commission, 2021. *Environment: Aarhus Convention, Public Participation.* [Online]
Available at: https://ec.europa.eu/environment/aarhus/
[Accessed 30 May 2022].

European Commission, 2021. *New EU forest strategy for 2030.* [Online]
Available at: https://environment.ec.europa.eu/strategy/forest-strategy_en#:~:text=New%20EU%20forest%20strategy%20for%202030&text=The%20strate

Co-funded by the European Union

gy%20will%20contribute%20to,and%20climate%20neutrality%20by%202050.
[Accessed 23 June 2022].

European Commission, 2022. *European Commission: Climate Action.* [Online]
Available at: https://ec.europa.eu/clima/index_en
[Accessed 13 May 2022].

European Commission, 2022. *Horizon Europe.* [Online]
Available at: https://ec.europa.eu/info/research-and-innovation/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe_en
[Accessed 13 May 2022].

European Council , 2022 . *European Council: Council of the European Union.* [Online]
Available at: https://www.consilium.europa.eu/en/infographics/climate-costs/

European Council, 2019. *Long-term vision: a climate-neutral EU by 2050..* [Online]
Available at: https://www.consilium.europa.eu/en/meetings/european-council/2019/12/12-13/
[Accessed 30 May 2022].

European Network for Environmental Citizenship, 2018. *Defining Environmental Citizenship.* [Online]
Available at: https://enec-cost.eu/our-approach/enec-environmental-citizenship/
[Accessed 30 May 2022].

European Research Executive Agency, 2022. *European Commission.* [Online]
Available at: https://rea.ec.europa.eu/news/breakthroughs-tackling-climate-change-powered-citizen-science-projects-2022-02-21_en
[Accessed 13 May 2022].

European Union , 2021. *Union of Equality: Startegy for the Rights of Persons with Disabilities ,* Brussels: Luxemburg: Publications Office of the European Union.

Gammans, M., Merel, P. & Ortiz-Bobea, A., 2017. Negative impacts of climate change on cereal yields: statistical evidence from France.. *Environmental Research Letters,* 12(5).

Giorda, T. 2022. *CitSci4All: Interview on Citizen Science and the participation of the Deaf and Hard of Hearing.* [Interview] (March 2022).

Havens, K. & Henderson, S., 2013. Citizen Science takes root. *American Scientist,* 10(5), pp. 378-385.

Howlett , R., Hoogstrate , M., Sitbon , L. & Balasuriya , S., 2021. Accessible Citizen Science, by people with intellectual disability. *ASSETS,* pp. 18-22.

Hügel, S. & Davies, A., 2020. Public participation, engagement and climate change adaptation: A review of the research literature. *WIRE's Climate Change ,* 11(4).

Co-funded by the European Union

IDA, 2016. *The 2030 Agenda & the CRPD.* [Online]
Available at: https://www.internationaldisabilityalliance.org/content/2030-agenda-crpd
[Accessed July 2022].

IDA, 2021. *International Disability Alliance: Climate Change is our Crisis Too! Persons with disabilities demand COP26 break the exclusion cycle..* [Online]
Available at: https://www.internationaldisabilityalliance.org/blog/climate-change-our-crisis-too-persons-disabilities-demand-cop26-break-exclusion-cycle
[Accessed 15 May 2022].

IDA, 2022. *International Disability Alliance.* [Online]
Available at: https://www.internationaldisabilityalliance.org/
[Accessed July 2022].

IMPETUS, 2022. *IMPETUS: Turning Climate Commitmens Into Actions.* [Online]
Available at: https://climate-impetus.eu/
[Accessed 13 May 2022].

INCREASE, 2020. I*ntelligent Collection of Food Legumes Genetic Resources for European Agrofood Systems.* [Online]
Available at: https://www.pulsesincrease.eu/
[Accessed 13 May 2022].

IPCC, 2022. *Climate Change is widespread, rapid and intensifying.* [Online]
Available at: https://www.ipcc.ch/2021/08/09/ar6-wg1-20210809-pr/
[Accessed 13 May 2022].

IPM Popillia, 2022. *Integrated Pest Management of Japanese Beetle.* [Online]
Available at: https://www.popillia.eu/
[Accessed 13 May 2022].

Irvin, A. & Stansbury, J., 2004. Citizen Participation in Decision Making: Is it Worth the Efford?. *ASPA Public Administration Review,* 64(1), pp. 55-65.

Irwin, A., 1995. *Citizen Science: A study of people, expertise, and sustainable development (Environment and Society).* 1st Edition ed. London: Routledge.

Kelly, R. et al., 2019. Social Licence through Citizen Science: a tool for marine conservation. *Ecology and Society,* 24(1), pp. 1-20.

Kraemer, D., 2021. *BBC News: Greta Thunberg; Who is the climate campaigner and what are her aims?.* [Online]
Available at: https://www.bbc.com/news/world-europe-49918719
[Accessed 30 May 2022].

Lampi, E., Lämsä, E. & Hämäläinen, J., 2021. *Towards Understanding the Forms of Participation and Knowledge-Building Activities in Citizen Science Projects.* [Online]

Co-funded by the European Union

Available at: file:///C:/Users/user/Downloads/Attachment_0.pdf
[Accessed 30 May 2022].

Levantesi , S., 2021. *Nature Italy.* [Online]
Available at: https://www.nature.com/articles/d43978-021-00136-0#:~:text=More%20intense%20rainfall%2C%20increase%20in,social%2C%20economic%20and%20health%20risks.

Lewenstein, B., 2022. Is Citizen Science a Remedy for Inequality? *The Annals of the American Academy of Political and Social Science,* 700(1), pp. 183-194.

LICCI, 2015. *Local Indicators of Climate Change Impacts: the contribution of local knowledge to climate research.* [Online]
Available at: https://opentek.eu/domain/?uuid=0a078c50-d656-45aa-be34-2374e9f509d5&entry_mode=view&f=licci
[Accessed 12 May 2022].

Lindsey, R. & Dahlman, L., 2022. *NORA Climate.gov, Climate Change: Global Temperature.* [Online]
Available at: https://www.climate.gov/news-features/understanding-climate/climate-change-global-temperature
[Accessed 30 June 2022].

Maanen , N. v. et al., 2020. Climate Impacts in Italy. *Climate Analytics,* pp. 1-57.

McKinley, D., Miller-Rushing, A., Ballard, H. & Bonney, R., 2017. Citizen science can improve conservation science, natural resource management, and environmental protection. *Biological Conservation,* 208(1), pp. 15-28.

Merced , W. D. et al., 2020. *A User Centered Inclusive Web Framework for Astronomy.* s.l., Education and Heritage in the era of Big Data in Astronomy.

Mosello , R. & Lami, A., 2014. Climate Change and Related effects on Water Quality: Examples from Lake Maggiore (Italy). *Global Bioethics ,* pp. 1-4, 95098.
Muséum national d'histoire naturelle and Sorbonne University, 2019. *Science-Ensemble.* [Online]
Available at: https://www.science-ensemble.org/en/projects/vigie-nature-ecole
[Accessed 12 May 2022].

NASA Earth Observatory, 2022. *NASA: World of Change: Global Temperatures..* [Online]
Available at: https://earthobservatory.nasa.gov/world-of-change
[Accessed 13 May 2022].

Natural History Museum, 2019. *Star-Spotting Experiment.* [Online]
Available at: https://www.nhm.ac.uk/take-part/citizen-science/star-spotting-experiment.html
[Accessed 10 May 2022].

Co-funded by the European Union

Nature, 2015. Rise of the citizen scientist. *Nature ,* 524(0), p. 265.

Nguyen, T. L. et al., 2016. Perceptions of Present and Future Climate Change Impacts on Water Availability for Agricultural Systems in the Western Mediterranean Region. *Water,* 8(11), p. 523.

Orlandi, F. et al., 2020. Impact of Climate Change on Olive Crop Production. *Atmosphere,* 11(6).

Papadopoulou, M. P. et al., 2020. Agricultural Water Vulnerability under Climate Change in Cyprus. *Atmosphere,* 11(6), p. 22.

Pateman , R., Dyke, A. & West, S., 2021. The Divesrity of Participants in Environmental Citizen Science. *Citizen Science: Theory and Practice ,* 6(1), pp. 1-16.

Pocock, M. et al., 2018. Developing the glocal potential of citizen science: Assessing opportunities that benefit people, society and the environment in East Africa. *Journal of Applied Ecology,* 56(2), pp. 274-281.

Saunders, M. E., Roger, E., Geary, W. L. & Meredith, F., 2018. Citizen Science in schools: Engaging students in research on urban habitat for pollinators. *Austral Ecology,* 43(6), pp. 625-642.

Schaefer , T., Kieslinger, B., Brandt, M. & Bogaert, V., 2021. Evaluation in Citizen Science: The Art of Tracing a Moving Target. In: K. Vohland, et al. eds. *The Science of Citizen Science.* Online: Springer Cham, pp. 495-514.

Science-Ensemble, 2019. *science-ensemble.org.* [Online]
Available at: https://www.science-ensemble.org/en/projects/vigie-nature-ecole
[Accessed 12 May 2022].

SciStarter, 2022. *Stream Selfie.* [Online]
Available at: https://scistarter.org/stream-selfie
[Accessed 10 May 2022].

Serandrei-Barbero, R., Donnici, S. & Zecchetto , S., 2021. Effect of climate change on the valley glaciers of the Italian Alps. *The Cryosphere Discuss ,* pp. 2021-241.

Sherbinin, A., Bowser, A., Chuang, T.-R. & Danielsen, F., 2021. The Critical Importance of Citizen Science Data. *Frontiers in Climate: Climate Risk Management,* 3(3650760), p. 0.
Silvertown, J., 2009. A new dawn for citizen scicence. *Trends in Ecology and Evolution,* 24(9), pp. 467-471.

Smith, J., 2022. Extreme Citizen Science Gives a Voice to the Marginsalized in Remote Communities. *HORIZON: The EU Research & Innovation Magazine.*

Stephanidis, S. & Stathis, D., 2018. Effect of Climate Change on Soil Erosion in a Mountainous Mediterranean Catchment. *Water,* 10(10), p. 12.

Co-funded by the European Union

Stockholms Universitet, 2022. *Become an algae professional and help the researchers this summer!* [Online]
Available at: https://www.su.se/forskning/forskningsprojekt/algforskarsommar/bli-algproffs-och-hj%C3%A4lp-forskarna-i-sommar-1.610246
[Accessed 12 May 2022].

TIME, 2019. *Greta Thunberg Gives Powerful Speech at UN Climate Summit.* [Online]
Available at: https://time.com/5684216/greta-thunberg-un-climate-action-summit-climate-speech/
[Accessed 10 June 2022].

UCL, 2016. *Department of Geography, Extreme Citizen Science: Analysis and Visualisaton (ECSAnVis).* [Online]
Available at: https://www.geog.ucl.ac.uk/research/research-centres/excites/projects/extreme-citizen-science-analysis-and-visualisation-ecsanvis
[Accessed 10 June 2022].

UNAPEI, 2022. *UNAPEI: Pour Une Societe Solidaire et Inclusive.* [Online]
Available at: https://www.unapei.org/
[Accessed 30 June 2022].

UNFCCC, 2022. *United Nations Climate Change.* [Online]
Available at: https://unfccc.int/
[Accessed 30 May 2022].

United Nations , 2022. *Artcile 21 - Freedom of expression and oppinion, and access to information.* [Online]
Available at: https://www.un.org/development/desa/disabilities/convention-on-the-rights-of-persons-with-disabilities/article-21-freedom-of-expression-and-opinion-and-access-to-information.html
[Accessed 23 May 2022].

United Nations, 2022. *Article 9 - Accessibility* [Online]
Available at: https://www.un.org/development/desa/disabilities/convention-on-the-rights-of-persons-with-disabilities/article-9-accessibility.html
[Accessed June 2022].

United Nations, 2022. *Climate Action Fast Facts.* [Online]
Available at: https://www.un.org/en/climatechange/science/key-findings

United Nations, 2022. *Conventions on the Rights of Persons with Disabilities (CRPD).* [Online]
Available at: https://www.un.org/development/desa/disabilities/convention-on-the-rights-of-persons-with-disabilities.html
[Accessed July 2022].

United Nations, 2022. *Article 27 - Work and Employment.* [Online]
Available at: https://www.un.org/development/desa/disabilities/convention-on-the-rights-

Co-funded by the European Union

of-persons-with-disabilities/article-27-work-and-employment.html
[Accessed 23 May 2022].

United Nations, 2022. *What is Climate Change?.* [Online]
Available at: https://www.un.org/en/climatechange/what-is-climate-change
[Accessed 13 May 2022].

Vetter, J., 2011. Introduction: Lay Participation in the History of Scientific Observation. *Science in Context,* 24(2), pp. 127-141.

WASLI, 2021. *World Association of Sign Language Interpreters.* [Online]
Available at: https://wasli.org/
[Accessed 23 June 2022].

WFD, 2016. *World Federation of the Deaf.* [Online]
Available at: https://wfdeaf.org/
[Accessed 23 June 2022].

Wicki, M. T. & Meier , S., 2016. Supporting Volunteering Activities by Adults With Intellectual Disabilities: An Explorative Qualitative Study. *Journal of Policy and Parctice in Intellectual Disabilities ,* 13(4), pp. 320-326.

Yanay-Ventura , G., 2019. 'Nothing About Us Without Us' in Volunteerism Too: Volunteering Among People with Disabilities. *VOLUNTAS: International Journal of Voluntary and Non-profit Organisations,* 30(1), pp. 147-163.

Co-funded by the European Union

Co-funded by
the European Union

https://citsci4all.eu/