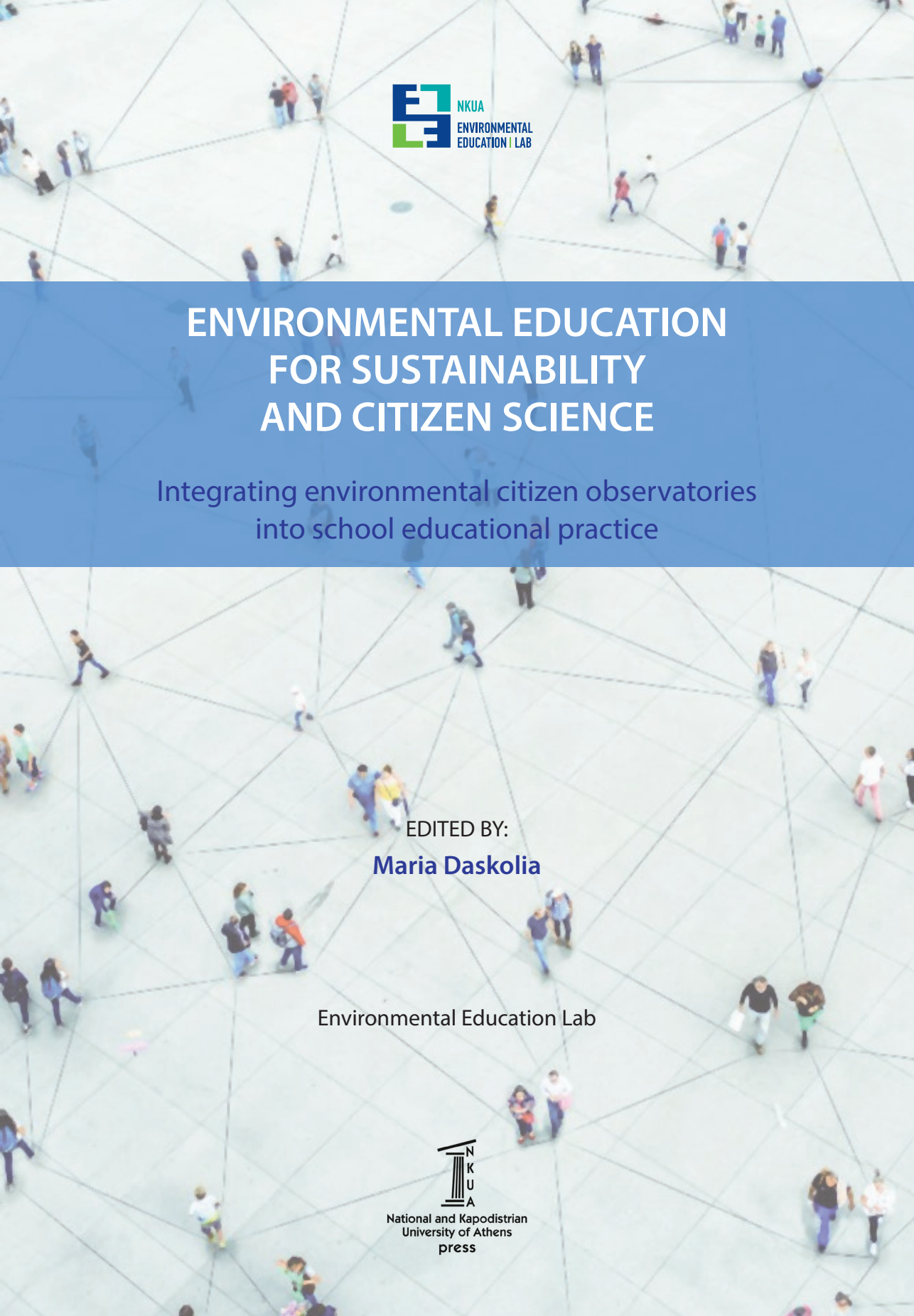

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ENVIRONMENTAL EDUCATION FOR SUSTAINABILITY AND CITIZEN SCIENCE

Integrating environmental citizen observatories into school educational practice

EDITED BY:
Maria Daskolia

Environmental Education Lab

National and Kapodistrian
University of Athens
press

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CONTENTS

INTRODUCTION

Maria Daskolia

Forging synergies between Environmental Education for Sustainability and Citizen Science

In the European Research and Innovation Programme "Science with society and for society", the European Commission refers to citizen science and education as two fields with several common features, which still need to be further highlighted and explored in conjunction with the ideas of open science and public participation for the benefit of the European societies (European Commission, 2020). In the same vein, both citizen science and education are recognised as critical assets in the efforts to shift current societies onto a more sustainable trajectory, through the development of creative synergies that engage citizens in learning processes and actions for the environment and sustainability at the local and global level (European Commission, 2022).

Citizen science is a new form of engaging non-professional citizen scientists or the general public in research or other types of scientific activity addressing specific scientific and social issues in the context of organised projects, broader communities and dedicated organisations, with the support and/or coordination of formal scientific groups and institutions (Bonney et al, 2014; Dickinson et al., 2012), often mediated by or involving the use of customized digital devices and online technologies (Woods, et al., 2022). It covers a wide range of practices aimed at opening science to society, and through this, to promote science, foster scientific literacy, encourage democratic community-

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based participation, and empower citizens to make informed decisions on key issues related to science and quality of life.

Although education and learning are not among the first and explicit goals of citizen science, there is an inherent relationship between them. As Roche et al. (2020) argue, education appears to intersect with citizen science in many aspects. First, it is among the public policy issues that, along with environmental protection, health and innovation, are promoted by a large number of related projects. It is also one of the fields that benefit the most from the knowledge generated through citizen science actions and initiatives. Finally, it is identified as a key mechanism to ensure that these practices are communicated to a wider audience and disseminated beyond individual and already motivated volunteers or ongoing projects.

Citizen science, on the other hand, serves several educational goals besides the strictly scientific ones (Kieslinger et al., 2018). Engaging in scientific processes, such as in data collection and analysis, is a type of learning process in itself, linked not only to the acquisition of content knowledge or basic skills about citizen science per se, but also to the development of scientific literacy in relation to the topics studied and the processes of their investigation (Brossard et al., 2005; Jordan et al., 2011; Saunders et al., 2018). This is one of the reasons why citizen science has also been associated with science education to date (European Commission, 2016; Bonney et al., 2016), mostly in non-formal and informal learning contexts.

Finally, it is important to note that a large number of citizen science projects and activities today, both in Europe and internationally, are thematically focused on environmental topics and issues (Vohland et al., 2021; Bonney et al., 2014; Dickinson et al., 2012), such as biodiversity monitoring, ecosystem surveying and environmental quality assessment. Through such projects, other objectives beyond the primary contribution to science are pursued, such as raising public awareness and engagement around these issues, informing and involving citizens in decision-making on local issues, and generating new and specialised knowledge for use in environmental management, policy and action in the face of contemporary sustainability challenges.

All these considerations point to the need to further explore the possibilities and opportunities for synergies between citizen science and education in formal learning environments (Roche et al., 2020). Can and does it make sense to integrate citizen science, both as a concept and as a practice, into the curricula of formal educational institutions such as schools and universities? And if so, on what terms and in what ways can a compatible, productive and mutually beneficial pairing be achieved, with both learning and broader

pedagogical advantages for the educational communities?

Our answer to the above questions is in the affirmative and what we suggest in this book is to explore the possibilities of linking citizen science with Environmental Education (EE) and Education for Sustainable Development (ESD). Both EE and ESD are two contemporary interdisciplinary and educational fields, with a shared theoretical underpinning and complementary background, but also with a significant record in school educational practice over several decades. Both are differentiated from (environmental) science education, as their orientation and objective go beyond the teaching and learning of fundamental scientific concepts, knowledge and skills that will lead to the development of a scientifically and technically sound approach to resolving current environmental problems (Wals et al., 2014). What is primarily sought through EE/ESD is the development of more holistic approaches to understanding the interconnections between socio-environmental conditions and human practices that shape current reality and form the complex challenges of sustainability; it is also the fostering of attitudes, values and skills required to get engaged in processes of individual and collective inquiry, active and critical knowledge construction and collaboration within the local community, all as prerequisites for shaping more sustainable communities (Jensen & Schnack, 1997· Breiting & Mogensen, 1999· Wals et al, 2014).

The basic premise that runs through the rationale and proposal of this book lies in the potential for pedagogical bridging between EE/ESD and citizen science. This is because, despite their clear differences, there are interesting "affinities" in the ways in which the two fields define themselves and the goals they pursue. These include, for example, the emphasis that both place on active participation in individual and collective research processes on contemporary environmental and sustainability issues, the advancement of the idea of environmentally active and responsible citizenry, the development of decision-making and action competence, together with environmental awareness and the fostering of a sense of place (Wals et al., 2014; Hecker et al., 2018; Tauginienė et al., 2020). However, as Wals et al. (2014) point out, despite the common grounds, there have not yet been enough efforts to develop creative synergies between EE/ESD and citizen science as a contribution to science, society and education towards achieving better terms for environmental and social sustainability.

This collective work sets and analyses the general framework and suggests ways for a pedagogically appropriate and beneficial integration of the idea, concepts and practices of citizen science, as well as the technologies that support its mechanisms and processes (the citizen observatories) in the school

practice of EE/ESD in Greece. Considering the whole endeavour to foster such synergies as an educational challenge and innovation (Harlin et al., 2018), we recognize teachers as key actors and facilitators in such educational processes (Weinstein, 2012). We also see their empowerment as being achieved in the context of appropriately designed training and professional development experiences, by offering them open access to pedagogically designed and responsive educational materials and teaching resources, and by creating a variety of networking and learning opportunities in communities that promote knowledge sharing, exchange of good practice and reflection on teaching practices.

Overview of the book: context, vision, outline, and contents

This book entitled "Environmental Education for Sustainability and Citizen Science. Integrating environmental citizen observatories into school educational practice", is based on a scholarly work produced by the academic head and members/associates of the research team of the NKUA's Environmental Education Lab (EEL) who participated in the European project Cos4Cloud (Co-designed citizen observatories for the EOS-Cloud). The Cos4Cloud project (https://cos4cloud-eosc.eu/) was implemented (2019-2023) by receiving funding from the European Union under the Horizon 2020 Framework, with the coordination of the Instituto de Ciencias del Mar of the Consejo Superior de Investigaciones Científicas (ICM-CSIC) and with the participation of 15 partners, among which EEL-NKUA. The main aim of the project was to boost the digital platforms and applications of citizen observatories, which are the main infrastructures for conducting citizen science nowadays, through the development of thirteen new technological services and their integration into the European Open Science Cloud (EOSC). The project's ambitions were to improve the quality of the data collection and analysis work as supported by the citizen observatories, to facilitate their different target populations and to ensure their sustainability in the future (Woods et al., 2022).

Among the wide range of actions promoted and supported by the Cos4Cloud project was the integration of the project's technologies and new services to the school educational communities. The collaborative design of educational and training materials, the empowerment of teachers through training and their networking in communities of learning and practice (Daskolia, Piera & Soacha, 2022), along with the pilot implementation of relevant school projects and their evaluation (Daskolia, Pappa, Joly, Bonnet, Arias, Piera, & Soacha, 2022; Daskolia, Trigatzi, Piera, Woods, & Bonnet, 2022) were the five pillars of the strategy developed and promoted by the EEL-NKUA

under Task 6.4.2 ("Design and evaluation of innovative school-based citizen science activities"). The overarching aim of this strategy was that the outputs and results of the various actions and initiatives launched, co-ordinated and implemented by the EEL-NKUA should form the basis for a model for long-term and large-scale engagement of school education communities in citizen science in Europe (Vohland et al, 2021; Woods, 2022). The overall contribution of the EEL-NKUA to the Cos4Cloud project is described in detail in the final Deliverable (D6.5) entitled "Design and evaluation of innovative school-based citizen science activities".

The idea for this publication emerged in the context of a set of interconnected actions designed and implemented by EEL-NKUA in Cos4Cloud. More specifically these were:

- The implementation of a 100-hour and six-month online training course (July - December 2020) for Greek teachers and educational stakeholders involved in the school practice of EE/ESD (Daskolia, Piera & Soacha, 2022). This e-learning course was designed and carried out by EEL-NKUA, with official approval and support of the Centre for Continuing Education and Lifelong Learning of NKUA, and was held on the digital platform Open eClass (https://eclass.cce.uoa.gr/courses/CCEHUMAN121/).
- The development of educational and training material by the EEL-NKUA team to support this online course, with the possibility of adapting it to support teacher training courses of shorter or equivalent duration, with similar thematic focus and objectives (Daskolia, Piera & Soacha, 2022).
- The collaborative design and creation of original educational scenarios by groups of teachers and educational stakeholders in EE/ESD with the guidance and scientific supervision of the EEL-NKUA team, which propose pedagogical uses of the digital platforms and tools of specific Cos4Cloud's Citizen Observatories (Daskolia, Pappa, Joly, Bonnet, Arias, Piera, & Soacha, 2022; Daskolia, Trigatzi, Piera, Woods & Bonnet, 2022).

This book had the above actions as its point of departure, but was based on a new elaboration of their outputs. Starting from the idea that citizen science offers opportunities to develop creative synergies between science, society, environment and education, which, when combined with the digital technologies provided by citizen observatories, can expand the scope and potential for research, participation and learning for sustainable development (Woods et al., 2022), this volume proposes and explores the pedagogical potential from bringing together EE/ESD and citizen science. The aim is to serve as a benchmark in the quite limited Greek and international literature on

the strengths and prospects of such synergies, as well as to propose field tested ideas for the implementation of relevant educational projects in primary and secondary schools that pedagogically integrate concepts, goals, processes and tools of citizen science.

Moreover, the choice to make this book an open access digital publication is in line with the vision of Cos4Cloud, which supports open science and the democratization of knowledge through digitalization and the promotion of open educational resources. This decision was also based on another consideration: to ensure the widest possible dissemination of the project's ideas and results to all stakeholders from the education sector (individuals, communities, organisations, institutions) and to support the Greek educational network (https://eecs-net-eds.eu/) established in the framework of Cos4Cloud, with the aim of promoting innovative activities integrating citizen science technologies into school EE/ESD. Finally, open, free and fair access to knowledge for all has been a fundamental principle and an underlying value pursued for every output and deliverable of EEL-NKUA in Cos4Cloud project.

The contents of this book are structured in two distinct yet complementary parts. The first part, entitled "Conceptual and Theoretical Considerations", comprises four chapters, through which it is sought:

- to define and delimit the scope of citizen science;
- to trace the links between citizen science and Citizen Observatories (COs) in the context of environmental protection, indicating a core and critical area of application for both;
- to introduce the European Cos4Cloud project and the concept of «open science» as a philosophy and practice of democratising and facilitating scientific research, with the support of citizen science; and
- to explore the relationship between citizen science and school education, focusing in particular on the potential for forging partnerships with Environmental Education (EE) and Education for Sustainable Development (ESD).

The second part aims, as stated by its title, to move "from theory to praxis", by presenting six educational scenarios, i.e. curricular plans that describe the terms, goals and modes of implementation for the development of pedagogical synergies between citizen science and EE/ESD in different grades and levels of schools. The scenarios were designed in a collaborative way by groups of teachers and school EE/ESD stakeholders in Greece, under the scientific supervision and guidance of EEL-NKUA. Their presentation is preceded by an introductory chapter discussing the identity, key features and specificities of

the approach taken by each of the six educational scenarios.

Overall, this publication, from its initial conception to its final form, is the product of collaborative design and creative co-authoring by a working group of researchers and educators who met, were inspired, exchanged ideas and experiences within EEL-NKUA and articulated their thoughts and ideas in the context of the Cos4Cloud's vision and goals. Warm thanks to all those who participated and contributed to this project, to the project coordinators, partners and collaborators, to the NKUA Publications for hosting this publication and to the European Community for funding the entire work. We hope that the book will find its way and inspire teachers and educational institutions, researchers and scientists, official state agencies, representatives of the civil society and ordinary citizens for more creative synergies!

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PART ONE

Conceptual and theoretical considerations

CHAPTER 1

CITIZEN SCIENCE:
KEY CONCEPTS, APPROACHES AND PRACTICES

Maria Daskolia & Paraskevi Kakaroucha

1.1 How is Citizen Science defined?

The term Citizen Science encompasses a wide range of actions and practices that attempt to connect citizens with scientific research. Therefore, Citizen Science can reasonably be seen as a very promising concept that arouses the interest of the scientific community, politics, education, and naturally the citizens themselves. It is a modern, multidimensional and integrated concept, expressing many needs, raising various expectations, and encompassing different visions. It is, thus, a dynamic, evolving concept. In this module an attempt is made to characterize it, based on the different definitions proposed to date.

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The term Citizen Science first appears in the 1990's, coined by British sociologist Alan Irwin and American ornithologist Rick Bonney, two pioneering founders of the field. Both attempted to define the field of Citizen Science independently, with Irwin (1995) focussing on one of its dimensions, namely the opening up of science to society and the general public (''science for the people''), and Bonney (1996) on a second, different one, the voluntary participation of ordinary citizens in scientific knowledge processes ("science by the people").

Image 1.1: Citizen Science
Source: European Commission

In one of the first attempts to define Citizen Science, Lewenstein (2004) refers to three pursuits that characterise its practices, all of which involve the engagement of either lay people or (professional) scientists/researchers, in research and in science-based decision-making. Specifically, Citizen Science seeks to: a) engage citizens in scientific processes of data collection, processing and interpretation, b) involve citizens in decision-making about public issues that have technical or scientific components, and c) engage research scientists in corresponding democratic processes.

Another characteristic dimension of the Citizen Science field referred to is: collaboration between citizens and scientists. This aspect is also highlighted in the definition added to the Oxford English Dictionary in 2014, according to which the term Citizen Science refers to ''scientific work undertaken by members of the general public, often in collaboration with or under the direction of professional scientists and scientific institutions".

Public participation in scientific research and collaboration between the public and scientists is also emphasized in the definition of Bowser & Shanley (2013). This definition also refers to the motivations for the motivations for participation and the nature of the research: citizens volunteer and contribute to scientific processes, either because they are interested in science and research or because they are concerned about real-world problems. This definition, among others, is essentially referring to a new type of engagement

with science, which breaks the barriers of traditional ''pure" science that is characterized by its distinct roles and the monopolistic production of knowledge by professional scientists.

Another official text on Citizen Science, the Green Paper on Citizen Science (2013), released the same year and signed by the Digital Science Unit of the European Commission and by Socientize.eu, highlights precisely this dimension of public engagement in scientific research processes. By getting involved, citizens can contribute to science and play a role in the production of scientific knowledge, making use of different tools and methodologies. In this way, the democratization of science is achieved, since the possibility is opened up for groups and networks of volunteers to carry out scientific work and, by collaborating with professional scientists, contribute to the achievement common goals. Based on all the above features, Citizen Science is an emerging 'paradigm' of scientific practice.

Thus, through the engagement of everyday people in scientific research Citizen Science is beneficial and synergistic for:

(a) science, since scientific knowledge is promoted and developed,

(b) society, not only by the opening up of the scientific information to the general public, but also by promoting democratic participation, cooperation, responsibility, transparency, consensus and justice for the people, through real-world problem solving, and

(c) citizens, by giving them the opportunity to express their own interests, acquire knowledge and cultivate a range of skills.

Specifically, through Citizen Science, participants are trained both as scientists and as citizens, in cultivating a scientific way of thinking and are encouraged in democratic engagement to address complex problems of the modern world, while contributing to the advancement of science as well as developing themselves through this (Ceccaroni et al., 2017).

1.2 How did Citizen Science begin and develop?

Citizen Science as a distinct practice, although not by that name, appears long before the end of the 20th Century. Many people in previous centuries, with no specific scientific training or qualifications, recorded their observations about nature, the world, man and society (Silvertown, 2009). However, the origins of the most most recent manifestation of Citizen Science could be traced back to the end of the 19th Century, when the term ''scientist" was coined (1833), replacing such terms as ''savant", ''philosopher of science", ''natural philosopher

or ''naturalist'', to describe someone who, although usually practising and making a living from some other profession, in their spare time engaged in their ''passion'', namely research - financed by themselves or by another sponsor.

Image 1.2: Citizen Science
Source: https://citizenscience.org

These first passionate amateur scientists pursued the study of various topics, often assisted by others in their personal network who helped them gather and analyse data. A typical example is Darwin, who travelled on the British Royal Navy Ship, ''HMS Beagle'', not as a professional researcher, but as an unpaid collaborator, to study geology, natural history and ethnology. His observations, which he recorded in a diary that was published in 1839 and entitled, "The Voyage of the Beagle", were instrumental in shaping his scientific theory of the evolution of species and natural selection. They established his reputation as a naturalist and made him known as one of the forerunners in the field of ecology, especially in the area of biocommunity issues.

The first collaboration initiatives between ''amateur'' and ''professional'' scientists date back to the end of the 19th - beginning of the 20th century, following the professionalization of science and establishment of scientific research. However, the high cost of laboratory equipment and, mainly, the rules of conducting experiments in the empirical sciences excluded the general public from formal venues for the production of scientific knowledge. Similarly, in several fields, the quality, accuracy and validity of the information gathered by the amateur scientists was called into question together with its interpretability.

Immediately after World War II, education of the population in the sciences was harnessed not only to raise morale and upgrade citizens' lives, but also to draw attention to a new human workforce in the realm of science that would

contribute to economic growth and national security while simultaneously boosting prestige during the Cold War (Rudolph, 2000). It enhanced, respectively, the image of science among the general population, making engagement with this field of knowledge self-rewarding.

The 1960's and 1970's were characterized by the social protest movements against the Vietnam War, nuclear weapons, the ecological crisis, the violation of human rights, etc. Amid this climate of controversy, science also came under harsh criticism as regards how oriented it was towards the real needs of humans. New research approaches, such as ''participatory action research" and "community action research" came onto the scene, highlighting the need for a more socially-oriented science and for a new model of 'scientist' with a political awareness consciousness and participation in the decision-making processes.

In the 1980's, discourses about the ''knowledge economy" and '' information capitalism" renewed the need for training in more interdisciplinary approaches centred on the basic sciences (Science, Technology, Engineering, Mathematics - STEM) and made scientific literacy an essential part of modern citizenship (Kosmin et al., 2008).

In the 1990s, the call for the democratization of science and the opening up of scientific knowledge to society, combined with the idea of empowering the citizen as a basis for a more democratic governance gave birth to the ''Citizen Science" movement and put it in the spotlight. At the same time, ''crowdsourcing", which had started to be discussed in this context at the beginning of the 21st Century (publication in WIRED magazine: Howe, 2006), further reinforced the whole idea by inviting the general public to contribute to scientific research and work.

Image 1.3: European Citizen Science Association - ECSA
Source: www.ecsa.eu

In the last decade, the rise in citizens' average educational level and the increase in their free time, combined with the development of information and communication technologies have accelerated advances in Citizen Science, although in different ways in different parts of the world. In Europe,

Citizen Science is now promoted in universities, research centres, museums and NGOs. The European Citizen Science Association – ECSA was founded to network the various bodies and the different actions throughout Europe and all over the world.

In some European countries (e.g. Germany, Austria) is supported by government grant schemes. In others, such as Ireland, Australia, Brazil or in Arctic regions, the fact that many of these actions are bottom-up initiatives has shaped also the terms used to reflect precisely this philosophy. In other countries, such as Austria, or Switzerland, the term, "Citizen Science" is so recent, or considered so innovative and unusual, that it is not even translated, and its content is adapted to the context and culture of the particular country.

Finally, it is worth noting that Citizen Science has been predominantly pursued within the realms of the natural sciences, while initiatives linked to the social sciences and humanities are rarer (Heiss & Matthes, 2017). A study by Hecker et al. (2018) showed that more than 80% of the Citizen Science projects reviewed related to the natural and life sciences and only 11% to social sciences and humanities. Nevertheless, the latter, although less visible and recognisable, seem to be forming a new, very promising area in the field of Citizen Science (Tauginienė et al., 2020).

1.3 How are citizens involved in Citizen Science activities and projects?

There are numerous ways in which citizens can be involved in Citizen Science activities and projects. This depends both on the nature of the Citizen Science activity/project, its theme and the scientific field it comes under or the research questions and methodologies used, as well as on the motivations, interests, skills, scientific expertise, and previous experience of the citizens themselves and their level of participation in the design of the activities/projects.

Whether as individuals, groups, or communities, citizens can participate in Citizen Science actions and projects in many different ways, for example, by:

- observing or recording species of flora and fauna,
- monitoring and contributing to the management of biodiversity and ecosystems,
- taking measurements related to environmental quality and public health (e.g. measuring air pollution, noise pollution, odour pollution, temperature, urban green space, etc.),
- providing personal data relating to physical and mental health indicators (e.g. age, weight, blood pressure, general well-being, attitudes, perceptions),

symptoms and epidemiological data,
- participating in experimental, clinical trials of drugs and treatment regimes,
- copying, categorizing, analysing or annotating information from websites and databases,
- testing or building the technological applications themselves,
- donating the unused processing power of their PCs to perform calculations etc.

In most of the abovementioned practices/ ways of participating in Citizen Science, citizens can apply one or more techniques or methods for data collection and analysis and use online platforms and digital tools (such as mobile phones) or special software. In fact, many of these practices can be facilitated, coordinated by, or end up in structures, such as Citizen Observatories, which have the appropriate digital infrastructures and offer the relevant services to those participating in their actions.

Bonney et al. (2009) propose another way of distinguishing the type and level of citizen engagement in Citizen Science based on the role that citizens play in it. It is also useful since it serves as a framework for designing a Citizen Science project. Thus, according to Bonney et al. (2009), there are three main types of Citizen Science projects:

1. Scientific research projects, where the public contributes to scientific research (**contributory projects**), without being personally responsible for designing and conducting it. Contributory Citizen Science features a top-down approach where the initiative and organisation are driven by the (professional) scientists. The role of the volunteer scientists (citizens) is to partly contribute to the project, primarily to collect data or, in the case of crowd sourcing, analyse data.
2. Scientific research projects, where the public has a more participatory role in conducting the research (**collaborative projects**). These projects too are generally designed by the (professional) scientists. However, in this case, the citizens participate in more than one stage of the scientific process (such as data collection and/or analysis, or helping to inform the way in which the questions are addressed, or communicating findings, etc.).
3. Scientific research projects, in which the public co-creates (**co-created projects**). This approach envisages scientists and the public (or communities of citizens) working together on the design. In these projects, at least some of the volunteer amateur scientists (citizens) are involved in all steps of the scientific process.

The overall experience of the Citizen Science project and its method of implementation will vary according to which of the above approaches is

followed. As will its design. While all the approaches have both advantages and disadvantages, deciding which is the most appropriate depends on many factors (see Text Boxes 1 and 2). Of course in reality all Citizen Science projects use a combination of approaches, perhaps including a core group of highly involved citizens who help to develop research questions and methods, alongside a wider group of citizens who contribute their observations or collect data.

Citizens contribute…

Citizen Science projects where citizens contribute mainly through recording observations and collecting data have several benefits. For example, they:

- Capture the imagination or align with the particular interests of citizens
- Gather a large volume of observations and data that, through other routes, could not be collected quickly, easily, over a wide geographic area and/or at a low cost
- Allow the recording of regularly, and/or rarely, encountered species or phenomena
- Enable large-scale analyses, that are better done by humans than by computers (e.g. identification of photos of wildlife species or museum specimens).

Frame 1.1: Citizens contribute…
Source: Tweddle et al. (2012)

Citizens co-create…

Citizen Science projects where citizens collaborate and shape the processes alongside scientists have several benefits such as in cases where:

- volunteering citizens help set up extended environmental quality monitoring systems or record conditions or hazards in an area
- small groups of volunteers collaborate on issues of common interest
- repeated measurements over time are required (and which therefore need a greater commitment from participants)·
- the projectd is targeted at resolving a place-specific environmental problem or question

Frame 1.2: Citizens co-create…
Source: Tweddle et al. (2012)

1.4 What are citizens' motivations for participation in Citizen Science?

Individuals involved in Citizen Science activities may be members of the educational community, i.e. teachers or pupils and students; they may be representatives of professional and scientific associations, or of environmental, naturalists and other voluntary bodies and organisations; they may be professionals, such as farmers or fishermen; or they may simply be citizens/ amateur scientists, whose professional status and activity may not necessarily be connected to the Citizen Science project in which they are participating, but who are personally motivated, and/or have the appropriate equipment, to make observations and measurements.

In general, the existing literature shows that citizens participate in Citizen Science projects for different reasons, the main ones being, according to Raddick et al. (2010), the following: their desire and intention to contribute to science by participating in research, their interest in the research topic, the enjoyment of engaging in research activity, sharing common goals and values, supporting and assisting other people, participating in a group, having their contribution acknowledged, seeking new sources of information and possibilities to learn, developing their creativity, achieving personal goals etc.

After interviewing several volunteers of the "Galaxy Zoo" Citizen Science project, Raddick et al. (2010), classified incentives for everyday citizens to participate into the following twelve categories:

- their interest in contributing to scientific research,
- learning,
- discovery,
- meeting other people with similar interests,
- sharing knowledge for educational purposes,
- enjoyment of beauty,
- fun,
- understanding the vast scale of the universe,
- being happy to help,
- interest in the platform and its subject matter,
- interest in the specific scientific discipline (i.e., astronomy), or interest in sciences in general.

Especially in the case of Citizen Science projects focussed on environmental issues, such as biodiversity, the motives of participants seem to be linked more to an interest in nature and less with society or career (Ganzevoort et al., 2017). In particular, such actions provide opportunities for: contact with nature and

the development of knowledge about nature-related issues; contribution to nature management and conservation, outdoor activity and connection with the place etc. In fact, frequent contact with a place, in order to perform measures or take samples, and collaboration with people who share common beliefs and values, strengthen the knowledge and connection with the place, interest and ''bonding'' with the area and cultivate feelings of personal responsibility and pride for their contribution to environmental protection.

Image 1.5: What motivates people to participate in Citizen Science projects
Source: https://citieshealth.eu/

On the other hand, the motivations of participants in Citizen Science projects may vary over time (Rotman et al., 2012; Rotman et al., 2014). The reasons that usually motivate citizens to participate in the first place are more personal and internal: the need for personal promotion and social or professional development, curiosity, interest in science and the desire to contribute to research. Subsequently, however, their reasons for continuing to participate are linked to their interest being sustained, their sense of personal efficacy, and time available. Citizens are interested in participating in another Citizen Science project after the first one when they like the activities involved, when they feel that they have the skills required for the project and when they can devote time to it regularly. Some participate for the first time on a trial basis and then drop out or participate less over time. Barriers to participating more consistently in such actions arise when citizens find the task dull or difficult or when they cannot devote enough time to it due to other obligations and

priorities. On the contrary, their participation is encouraged and their interest sustained when they become familiar with the task and the other participants, when a team spirit is cultivated and when their effort is recognised. (Jennett et al., 2016).

Image 1.4: Citizens participate
Source: Cos4Cloud

1.5 What are the principles of Citizen Science?

Citizen Science is a scientific research process and, like any other related process, has to follow certain principles. These principles vary according to the research project concerned, the topic/theme and the scientific discipline it comes under. With these as criteria, the types and degree of citizen participation, the stages of the research process, the practices, methods and types of data are determined differently. Likewise, different terms are used to refer to the contribution of the citizens involved (e.g. the terms ''residents'', ''community members'', ''participants'', volunteers'' or ''scientists-activists''). To overcome the obstacles created by the differences between the scientific disciplines Ceccaroni et al. (2017) propose the creation of a single standardised vocabulary and a common methodology for Citizen Science. In this way it is assumed that issues of quality control and assurance of the processes will be covered. The European Citizen Science Association - proposes (2016) a framework for good practices for the design and implementation of Citizen Science actions.

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The 10 principles of Citizen Science

Citizen science is a flexible concept, which can be adapted and applied within diverse situations and disciplines. The statements below were developed by the 'Sharing best practice and building capacity' working group of the European Citizen Science Association, led by the Natural History Museum London with input from many members of the Association, to set out some of the key principles which as a community we believe underlie good practice in citizen science. Translation into Greek by Maria Aristidou, postdoctoral researcher at the Open University of the United Kingdom and a member of ECSA, and Despina Kouretsis, postgraduate student at the Department of Education at the University of Athens.

1. Citizen science projects actively involve citizens in scientific endeavour that generates new knowledge or understanding. Citizens may act as contributors, collaborators, or as project leader and have a meaningful role in the project.
2. Citizen science projects have a genuine science outcome. For example, answering a research question or informing conservation action, management decisions or environmental policy.
3. Both the professional scientists and the citizen scientists benefit from taking part. Benefits may include the publication of research outputs, learning opportunities, personal enjoyment, social benefits, satisfaction through contributing to scientific evidence e.g. to address local, national and international issues, and through that, the potential to influence policy.
4. Citizen scientists may, if they wish, participate in multiple stages of the scientific process. This may include developing the research question, designing the method, gathering and analysing data, and communicating the results.
5. Citizen scientists receive feedback from the project. For example, how their data are being used and what the research, policy or societal outcomes are.
6. Citizen science is considered a research approach like any other, with limitations and biases that should be considered and controlled for. However unlike traditional research approaches, citizen science provides opportunity for greater public engagement and democratisation of science.
7. Citizen science project data and meta-data are made publicly available and where possible, results are published in an open access format. Data sharing may occur during or after the project, unless there are security or privacy concerns that prevent this.
8. Citizen scientists are acknowledged in project results and publications.
9. Citizen science projects are evaluated for their scientific output, data quality, participant experience and wider societal or policy impact.
10. The leaders of citizen science projects take into consideration legal and ethical issues surrounding copyright, intellectual property, data sharing agreements, confidentiality, attribution, and the environmental impact of any activities.

April 2016, Milton Keynes, UK

Text Box 1.3: The ten principles of Citizen Science
Source: European Citizen Science Association (2016)

1.6 What are the benefits from the development of Citizen Science?

There is a wide range of expected benefits from Citizen Science actions in society, including the following: development of scientific literacy, participatory innovation (Hecker et al., 2018), convergence of research with sustainability policies (Petridis et al., 2017; West & Pateman, 2017), transfer of knowledge

from one piece of research to another or for use in the personal and collective life of the participants, connection of science with education and the needs of the community, etc. (Tauginienė et al., 2020).

Citizen Science is a new paradigm of science, which changes the way science is perceived and how citizens participate in it. It is a collaborative and two-way process of research, education and action, oriented towards social change. ''Expert'', ''accredited'', ''professional'', academic researchers work together with ''non-expert'', ''non-accredited'', ''amateur'', volunteers, non-academic researchers, to jointly examine a ''problem'' and propose solutions to benefit all interested parties and society as a whole. The ''experts'' organize, coordinate and supervise the actions, to which the citizens contribute their ideas, energy or, and often, also their equipment. However, even though this collaboration is based on mutual respect and mutual support, ''experts'' and ''non-experts'' are not considered equal in everything, since they do not have the same resources (background knowledge, time, logistics/infrastructure etc.), nor do they have the same motivations (Haklay, 2015). They are, however, complementary.

Citizen Science can empower citizens as individuals or citizen groups and communities, by giving them the opportunity to draw attention, through scientific research, to issues that concern them at a local, national or international level. By collecting data and information, drawing on collective and traditional knowledge and expertise, formulating proposals or communicating the results via their social networks, citizens can influence decision-makers or even force them to take action and policies. In any case, Citizen Science should not be used as a tool for transferring responsibility for important social functions to individuals (Brown, 2015), nor should it make up for the underfunding of scientific research that currently afflicts most countries.

1.7 How is Citizen Science connected to education?

Education is a critical facet, goal or output of most of the above-mentioned Citizen Science actions and initiatives. As stated by Serrano (2013), in order for people to better understand science they need to participate in scientific research processes, whereas the production of scientific knowledge itself is by definition associated with learning or should lead to it. Many of the citizens participating in Citizen Science projects have formal qualifications (e.g. academic credentials, knowledge of foreign languages, technological skills), which are not necessarily connected with the subject matter and methodology of the action they are involved in: they may have very few or no formal qualifications, but many years of experience and involvement in the field, or even neither of the two (formal qualifications or previous experience).

They may be self-taught or have sought to acquire the relevant knowledge through an organized educational project alongside, or after completing, the activity in which they are taking part. In any case, Citizen Science is a new pathway to increasing scientific literacy through the acquisition of new content knowledge and research skills (Jordan et al., 2012).

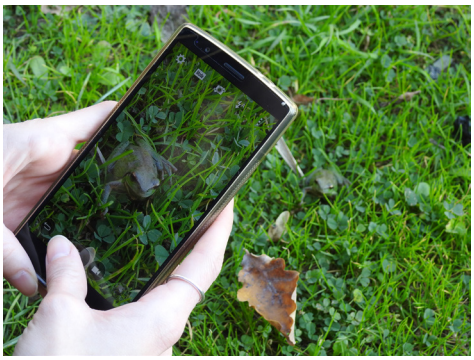

Image 1.6: Citizen Science, education & learning
Source: Cos4Cloud

To date, however, the connection between Citizen Science, education and learning has mainly concerned the involvement of adults, and this is because they were the main target-population from the outset. Citizen Science has been developed very little in formal school education, compared to non-formal and informal education (such as in museums, interest groups, NGOs, etc.).

Nevertheless, in recent years, it has been increasingly recognized that Citizen Science can be a valuable educational approach within schools as well, where engaging students in relevant activities can create numerous learning benefits. Specifically, Ballard, Dixon & Harris (2017) uphold that the participation of young people in Citizen Science actions relating to the natural environment contributes to: raising their environmental awareness, developing their knowledge of ecology, gaining experience from participation in scientific processes, strengthening their connection with nature and actively involving them within the local community. Interdisciplinary and cross-thematic teaching is also facilitated as is the learning of different subjects/disciplines and through all the above environmental education for sustainability is promoted (Wals, Brody, Dillon & Stevenson, 2014).

To sum up…

In the first chapter of this book an attempt was made to define and delimit the field of Citizen Science.

In particular, some of the established definitions of Citizen Science were given, a historical review of events that determined its genesis and development to date was provided. Furthermore, different ways in which citizens are involved in Citizen Science practices were presented with reference to the factors that motivate citizens to participate in these practices. Finally, some of the benefits arising from its dissemination and implementation it were and the basic basic principles underlying it were outlined, and finally, and its relationship with education was considered at a first level.

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CHAPTER 2

FROM CITIZEN SCIENCE TO CITIZEN OBSERVATORIES.
SUPPORTING ENVIRONMENTAL PROTECTION IN PRACTICE

Maria Daskolia & Dimitrios Gkotzos

2.1 How can Citizen Science contribute to environmental protection?

THe wide scope and complexity of modern environmental issues poses serious challenges in the fields of biodiversity conservation, natural resource management and environmental quality in general. Most human activities and practices in modern societies bring about important and rapid changes to environmental systems. Climate change, urbanization, deforestation, and converting nature into arable land all reduce the ability of ecosystems to sustain life, create a range of dangers for many species of flora and fauna, and degrade the well being and quality of life of human societies (Steffen, Grinevald, Crutzen, & McNeill, 2011).

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On the other hand, initiatives to protect the environment are comparably little when compared to the pressures exerted onto ecosystems. Furthermore, in addition to the functions and dynamics of natural ecosystems, social, cultural and political factors that affect them need to be considered in order for these initiatives to be effective. Finally, an essential parameter for any environmental protection initiative is the active participation of citizens and their mobilisation/involvement in defending and and developing sustainable solutions.

Citizen Science presents a great opportunity in the effort to combat the various challenges posed to the environment on several levels, and can function as a "tool" for environmental protection in several ways (McKinley, Miller-Rushing, Ballard, Bonney, Brown, Cook-Patton, & Ryan, 2017), such as:

(a) the development of scientific and general knowledge in the fields of conservation/management of natural resources and environmental protection,

(b) assisting in informed decision-taking for environmental policy making at a local, national and international level,

(c) encouraging public participation and inspiring citizens to take interest andactively participate in environmental protection issues.

Image 1: CS in the service of environmental protection
Source: P2P Foundation (https://blog.p2pfoundation.net/grow-a-new-online-course-to-sense-the-world-around-us/2018/03/27)

In particular, a large number of Citizen Science projects involve citizens in essential and applied scientific studies on various ecological and environmental subjects and matters (Dickinson, 2010). Some of these projects include, for instance, the monitoring of key ecological and environmental indicators, the monitoring of endangered flora and fauna species, the recording of environmental observations, and providing information on environmental management initiatives. Other projects focus on environmental issues

occurring at a local level, such as identifying the source of pollution in a river. Others yet focus on matters of a global scale, such as climate change and cross-regional movements of population. Through Citizen Science, volunteers and amateur scientists involve themselves in data collection, as well as the collection of further scientific observations in various environments such as forests, grasslands, wetlands, beaches, lakes, rivers, and even in city neighbourhoods and gardens.

Image 2: Citizen scientists in action
Source: Can Citizen Science empower disenfranchised communities? (2016). Citizen Science Partnerships (https://citizensciencepartnerships.com/2016/02/09/can-citizen-science-empower-disenfranchised-communities)

It's also important to note that many wide-scale researches on environmental issues would not be possible without the involvement of volunteers in activities such as providing scientific information on a long-term basis, taking part in scientific observations over large geographical regions, recording extraordinary events or emergency situations, or reporting the random/sudden appearance or fluctuation in frequency of certain species (Stepenuck & Green, 2015). Citizen Science thus facilitates the conduct of scientific research and contributes to the development of scientific knowledge on environmental issues and concerns. In turn, these can inform the various initiatives and actions regarding environmental protection, environmental governance, and environmental policy.

How citizen science is helping combat air pollution in Brussels?

This is an indicative case as to why monitoring environmental quality is a main focus of Citizen Science:

The 1.2 million inhabitants of Brussels do not know much about the air they breathe daily. Let's take, for instance, particulate matter PM2.5. The observation stations that record the levels of this pollutant in Brussels can be quite literally counted with one hand, as they are five in total. However, for a city of over 160 sq.km, these are too few.

Given that public authorities do not seem to intend to inform the citizens of Brussels about air quality - even following submitted complaints made by inhabitants - it appears Citizen Science can play an important role. Thanks to the low cost of particulate sensors (a single sensor costs €30), citizens can install one in their homes and thus contribute to creating a dense network of reading points. In Brussels, 400 people have already registered to partake in this project. Some schools are also registered to participate (see figure 3).

The data that will be collected from these devices will provide a precise picture in real time, and also track the spatio-temporal evolution PM2.5. This will help both scientists and city authorities to better understand and deal with pollution by taking relevant actions. Apart from the scientific data collected by the official observation stations, the project will also function as a way to raise public awareness with regard to air pollution. Through active participation, people become more interested in the issue and understand it better. As a result, it becomes easier for them to take action, such as, for instance, opting for public transport rather than a personal vehicle.

Are these low-cost sensors reliable enough to be used as an air pollution measuring instrument in a city like Brussels? To answer this question, a comparison between their measurements and that of scientific observation stations was conducted. The conclusion was that, although there were slight deviations, general reading tendencies remain the same. This meanings that this particular Citizen Science project can surely contribute greatly towards greater awareness as to where, when and how air pollution in the city increases or decreases, leading to appropriate measures being taken (Dornier, 2019).

Source: Dornier, P. (2019). How citizen science is helping combat air pollution in Brussels.
Available at: https://www.transportenvironment.org/news/how-citizen-science-helping-combat-air-pollution-brussels

Text Box 2.1: An indicative case of environmental quality monitoring
Source: Dornier, 2019

Citizen Science also goes beyond just strengthening scientific research in the aid of developing environmental policy. It also offers opportunities for participation in the development of new open access environmental knowledge, which most citizens can approach, understand, and trust (McKinley et al., 2017). Additionally, Citizen Science promotes scientific and

environmental literacy in citizens. This form of literacy is connected equally with scientific, regional, and traditional knowledge. It cultivates and supports discourse and participation in decision making concerning environmental issues. Through the broader exchange of scientific information, it contributes to the search for further solutions and synergies in environmental protection efforts. It engages and inspires citizens to actively participate in protecting the environment in two ways: First, directly, when citizens make use of what they learned by participating in a Citizen Science project and can better understand or comment on a government or otherwise administrative decision; Second, indirectly, when they share information in their communities and encourage others to get involved in the protection and management of natural resources and the environment, as well as in dialogue and policy decisions.

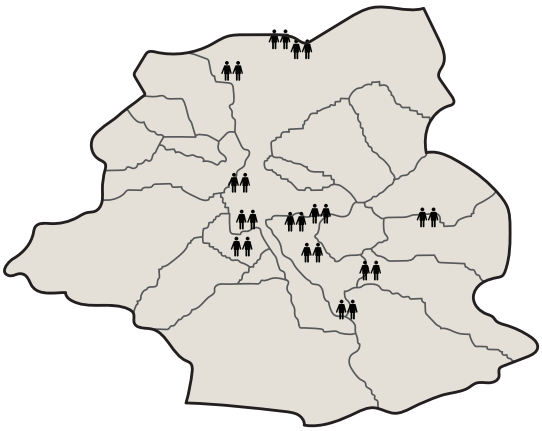

Image 3: Schools in Brussels participating in the Citizen Science project for particulate PM 2.5
Source: Dornier, 2019

Finally, Citizen Science helps citizens to develop a relationship with the environment by fostering their interest and care for it (Ballard, Dixon & Harris, 2016). Through citizen's involvement with local environmental protection issues, their relationship with the land is strengthened. Citizens are challenged and motivated, furthermore, to set new criteria in relation to their personal choices and habits on matters of environmental care and management. The interest and knowledge that is developed in Citizen Science projects flows down to friends, family, colleagues and other social networks through sharing their experiences in the activity, as well as through discussion of the topics emerging from the experience. This way, more citizens are challenged and inspired to change their stances and habits on issues of environmental protection and management.

2.2 What are Citizen Observatories?

Citizen Observatories are a new concept and an emerging reality that is inextricably linked with Citizen Science. In essence, it is an idea that emerged from international organizations and EU environmental policy committees. It seeks to combine participatory observation by members of a community, advanced technologies, and formal facilities and mechanisms for the observation and management of scientific environmental issues by the broader public.

Both the idea and term "Citizen Observatory" is recorded, possibly for the first time, in a keynote given in 2009 by Jacqueline McGlade, professor of marine biology and environmental informatics at the University of London, on the role of citizens with regard to monitoring and understanding a changing world. Among other things, McGlade argued that the role of citizens should not be limited to being passively informed by third parties (such as scientists and politicians). Rather, they should be actively involved in monitoring and recording how their environment is changing. Towards this aim, she invited organizations that support large digital environmental monitoring systems to open their doors to local knowledge, and empower citizens to participate in their activities, themselves monitoring and gathering information and data about their local environment (McGlade, 2009).

Image 4: Discussion and recording
Source: WeObserve, 2018

As to the meaning of Citizen Observatories, various definitions have been suggested, most of which refer to their function, means and goals. According to Liu, Kobernus, Broday and Bartonova (2014), the majority of COs are "spaces" of participatory governance, in which citizens collect observations

and references with regard to particular environmental issues, making use of digital applications and social media. In another attempt at defining the term, Alan Grainger (2017) includes, under the concept of COs, any use of Earth observation technology, through which citizens collect data and are simultaneously emboldened by the information produced to participate in managing their environment. Additionally, the notion of COs has been approached through the framework of an "ecosystem". Ciravenga, Huwald & Lanfranchi (2013) thus define COs as "a method, an environment and a technological infrastructure that, all together, create an ecosystem in which citizens, communities, but also specialised institutions converse, monitor and intervene in relation to certain situations, areas and events" (pg. 146).

The European Commission (EC) has played a decisive role in the implementation and development of the concept of COs through the various initiatives promoted over the last decade to strengthen such institutions and services at a political and financing level. According to a definition provided in one of the recent invitations of interest for the support of such initiatives, COs are defined as "community-based systems of information monitoring and management, which utilise new and innovative technological observation applications, connected to or built into mobile or portable devices. Owing to the wide range of information and data that can be collected and made available, COs can provide to relevant authorities the required documentation to inform their environmental policy, supplementing more formal networks and systems of local monitoring and observation, while also aiding all parties involved" (SC5-19-2017).

In the above definitions, certain common elements are observed that underly the concept of COs, such as promoting citizen participation in environmental monitoring and management, the bi-directional flow and use of data and information, their complimentary function with more formal systems of environmental observation and recording through citizen-made on-site comments, and the use of modern technology as a basis for achieving this goal.

2.3 What are the main aspects and characteristics of Citizen Observatories?

A central aspect in the function of COs is the use of digital technologies, both as infrastructure and services provided. More specifically, citizen/user participation in a CO is contextualised and supported by a digital platform and the use of specialised technological equipment and tools, such as fixed or mobile sensors and daily-use mobile devices, as well as specialised software and

Web 2.0 applications. These "accessible" digital capabilities enable and support citizen involvement in activities of monitoring, recording and making use of information, such as measuring levels of air pollution or radiation, or calculating environmental danger posed by flooding based on water measurements in a riverbed. These activities are based on personal, subjective and/or objective observations and recordings, but also on information, comments and files exchanged by CO users for collection, sharing and publication, which are aided by the digital technologies, tools and services used. Through these two basic aspects (a. Open digital infrastructure and services, and b. Personal observations and recordings), COs promote volunteer participation, but additionally, the cooperation and exchange of information in the context of the citizen/user community, which support and strengthen the benefits on a scientific and social level (Morandi, Iacopo, Enrico, Ian & Stewart, 2013 in Montagril & Santos, 2017).

Image 5: Citizen scientists in action
Source: WeObserve, 2018

Active citizen participation in environmental monitoring is, according to the Finnish Environment Institute (2016), another basic aspect of most active COs. While monitoring is considered a fundamental requirement for environmental protection and management, public education and awareness-raising is also sought after as an aim, providing thus opportunities for meet-ups and cooperation between one community and another, therefore creating social capital for sustainability. On this basis, Rubio-Inglesias (2013), highlights the following four characteristics as distinguishing features of the operation of COs:

- Citizens are not simply receivers of information, but important transmitters / creators of information produced and shared.
- New opportunities emerge for the role of citizens, such as being given the means to collect, combine and use important information more times, based on the needs and requests posed by them.

- Environmental governance can be supported in more levels, such as through evaluating success of various environmental policies.
- Complementarity with other systems of environmental monitoring is also promoted, greatly strengthening the degree and scope of on-site observations, while also reducing public cost.

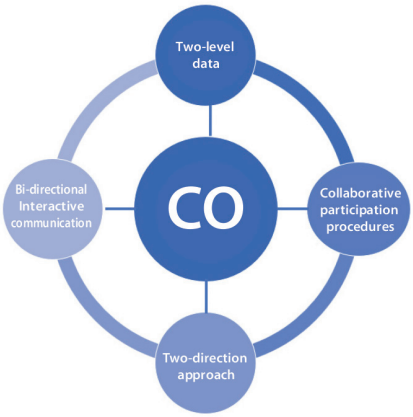

Figure 1: Conceptual framework of a Citizen Observatory (Liu et al., 2014).
Source: Liu et al., 2014.

Based on the above, COs constitute initiatives that focus on the broader community and seek to achieve the social change that occurs when citizens become more involved in the collection and exchange of environmental information, through the use of services provided by advanced technological developments (such as, for instance, seamless connectivity to the Internet, the Internet of Things [IoT], Social Media, cheap and portable sensors etc.). Additionally, COs provide citizens with the opportunity to cooperate, become informed and actively participate in environmental decision taking, to raise awareness with regard to environmental issues, and to contribute to the creation of more resilient societies (Group on Earth Observations).

2.4 What are the fields of application for Citizen Observatories?

Thematically, the majority of COs focus almost exclusively on environmental monitoring. However, in more recent years, cases of COs involved in other issues have been recorded. They remain, nevertheless, much fewer. Specifically in Europe, almost 80% of known and recognised COs promote the recording and collection of information such as on various species of flora and fauna, biodiversity, air, water, rivers and streams, snow, the sea, precipitation and,

naturally, climate change (see Figure 2).

More than 16 European countries actively participate in one of the various types of COs. The United Kingdom is by far the most active country in this domain, hosting 38% of all environmental COs in Europe. Greece is among these 16 countries too, albeit with a small amount of representation (3%). Finally, there is a 15% of environmental COs that are not strictly connected with one country, but with the whole of the EU (Finnish Environment Institute, 2016).

In an attempt to depict the situation regarding various COs, the European project WeObserve suggested the following categorisations based on their field of application (WeObserve, 2018).

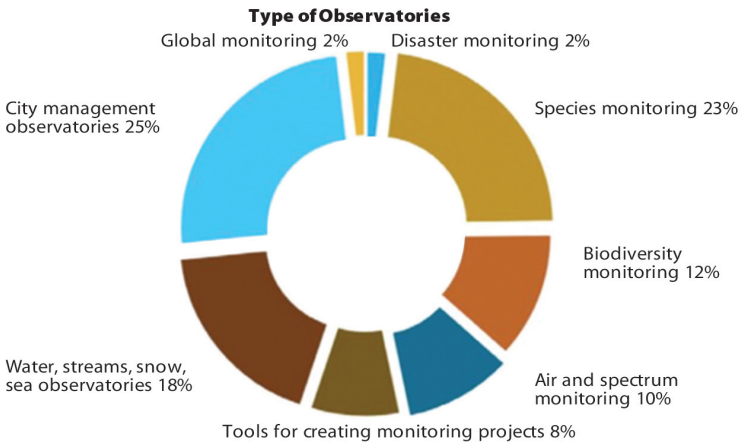

Figure 2: Types of Observatories
Source: Palacin-Silva et al., 2016 στο: WeObserve 2018

Categorisation of Citizen Observatories based on their field of application

Observatories of city management, that support decision making on issues regarding city management, such as: transportation, bicycle routes, land usage, energy consumption, surroundings classification, environmental conditions, traffic and parking monitoring, citizen needs and perceptions (Case examples: FixMyStreet, SeeClickFix, VizWiz, Waze, CiclePhilly).

Observatories that collect data about water, rivers, the sea, as well as water quality, precipitation, streams, lakes, snow, ice and sea environments (Case examples: CURA H20, Järviwiki, Brooklying Atlantis, Lakewatch, CoCoRaHS).

Biodiversity monitoring observatories, that focus on flora, forests, mountains, biosphere and trees (Case examples: Plant Watch, Leaf Watch, iNature, Mountain Watch).

Air and spectrum monitoring observatories, meaning observatories that gather data about air quality, noise, sounds, and radiation, especially in cities (Case examples: Common Sense, SafeCast, Noise Tube, CitiSense, Bucket Brigades).

Observatory tools for creating monitoring projects, involving tools that are useful for the creation or integration of citizen observatories, such as: configurable citizen observatories (plug-and-play tools), image classification components and sensor-monitoring components (Case examples: Glassnost, Ushahidi, CitSci, Public Lab).

Global monitoring observatories, on issues of astronomy and climate change, that seek to monitor global trends (Case examples: Galaxy Zoo, Spring Watch, GLOBE at Night).

Disaster and crises observatories, that focus on, for example, earthquake monitoring and their early detection (Case examples: iShake, Did you feel it?).

Land-use observatories, that deal with issues of land use, land cover, and change in land use or land, in both rural and urban settings.

Commodity-based monitoring observatories, that focus on economic, social or environmental cover value, such as fisheries and forestry activities.

Text Box 2.2: Categorisation of Citizen Observatories based on their field of application

2.5 What is the relation between Citizen Observatories and Citizen Science?

Citizen Science could be broadly defined as "making science accessible to society" and "promoting citizen participation in scientific research". More specifically, and as noted in Chapter 1, the demand to democratise science has been documented since the 1970s. A well-known representative of this current is the philosopher of science P.K. Feyerabend, who argues that the monopoly on research by universities, companies and large institutions is contrary to the interest of science, which has a long history of involving ordinary citizens. As he notes in one of his characteristic aphorisms: "Everywhere, science is being enriched with non-scientific methods and non-scientific results" (in Liu et al., 2014). However, several attempts between 1970-1990 to get ordinary, non-scientific citizens involved in research, proved to be fruitless.

Image 6: Citizen Science Promotional poster
Source: ΕΚΤ (2016). Καινοτομία Έρευνα & Τεχνολογία, 104. (http://kainotomia.ekt.gr/issue/2016/104/files/assets/basic-html/index.html#1)

With the advent of the new millennium, demand returned to a renewed form, as the desire to promote active societal participation in science. In response to this, the European Union, through the project SOCIENTIZE (2012-2014), created a joint forum of cooperation between IT infrastructure providers and service providers for Citizen Science. In this forum, any user interested in could participate in the scientific process. The "Green Paper on Citizen Science" came out of this project, which provided a roadmap for the development and implementation of Citizen Science in Europe. Its publication led to a series of further initiatives, out of which Citizen Science became interlinked with the notion of "democratic participation of society in scientific research".

On the other hand, COs realised an idea emerging from EU environmental governance and policy circles; an attempt to practically combine participatory monitoring, use of technology and strengthening government structures in

order to record and manage the environment. Active participation of ordinary citizens through COs is promoted, essentially, as the key to protecting the environment.

Figure 3a: Citizen Science as a concept underlying that of COs

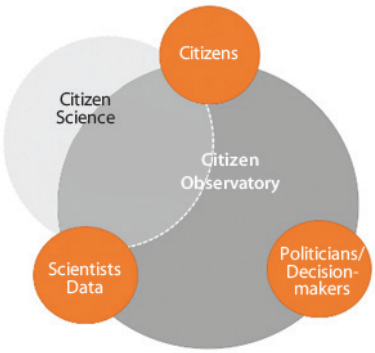

Figure 3b: Commonalities between the concepts of Citizen Science and COs

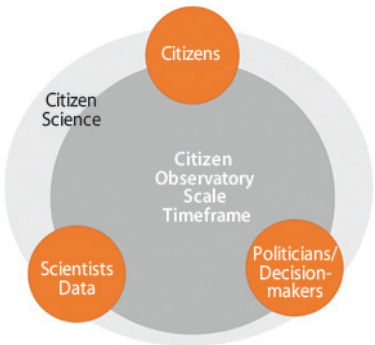

Figure 3c: Citizen Science as a concept overlapping that of COs

A crucial drawback of traditional forms of environmental monitoring (e.g., satellites and on-site observation in official research networks) is the lack of active participation and immediate experience by citizens on issues that concern them, a factor that also obstructs their participation in decision-making processes in their community. The development of COs as an institution, therefore, constitutes an important step in bridging the gap between environmental knowledge and active participation in environmental governance and citizens (Liu et al., 2014).

In the context of both Citizen Science and COs, citizen-volunteers participate in scientific research or monitoring projects, while being guided towards playing an active role in data collection processes and/or the commenting, sharing and information exchange, towards approaching specialists who will answers their questions, and towards they themselves contributing towards greater understanding and decision-making on issues that are of concern to their community.

Additionally, through the specialised services offered, they seek to invite, host and support voluntary participation and action/observation by citizens. The relation between Citizen Science and COs is described through three versions (see Figures 3a,3b,3c based on the discussion at CoP Launch Workshops - Geneva, 2018):

According to the first version, Citizen Science is a concept underlying that of COs. Although it is included entirely in the scope of COs, it is but one part of it, distinct but limited. Specifically, it is connected with data collection procedures on the citizen's part within a scientific research framework, enacted under the responsibility of certain scientists or scientific groups, but always within the scope of COs.

According to the second version, there are commonalities between the concept of Citizen Science and COs, that, like in the previous version, are about citizen/scientist participation and common research projects, and also include data collection and analysis. Each of the two, however, have a field of activity that operates separately from the other. In both the first and second version, the concept of COs is naturally broader than that of Citizen Science, since it's connected with empowering citizens to participate in decision-making and policy.

Finally, according to the third version, the concept of Citizen Science overlaps that of COs. COs field of operation is included entirely in that of Citizen Science, with COs being a big (perhaps even main) part of the field of Citizen Science, and a dominant expression of Citizen Science. There are, however, other Citizen Science actions and initiatives that are not included in

the work and operation of COs. We could therefore say that Citizen Science infrastructure is delimited as COs on the basis of their focus (mostly monitoring the environment), the scale of their activities (mostly local) and the time frame for their implementation (mostly long-term) (WeObserve, 2018).

In essence, the idea behind both is common: Both through various Citizen Science projects and CO framework, citizens are called and empowered to participate, with the goal of them playing an active role in the collection of significant information that will allow better understanding and management of these issues, alongside raising awareness, improving participation and supporting decision-making. Grainger (2017, pg. 5) notes that COs differ from Citizen Science in the following two aspects:

a) Information gathered and created in COs must, by definition, directly benefit citizens and society at large, as opposed to science alone, as happens in many of the more conventional Citizen Science projects.

b) Organizationally, COs constitute more elaborate structures and procedures compared to Citizen Science projects. Owing to greater citizen participation from the starting phases, most COs are conducive to co-creation and participation to a greater degree on the citizen's part, and in more ways than merely contributing to data collection.

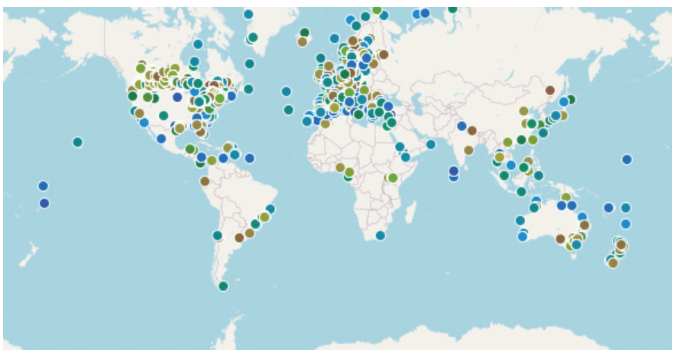

Image 7: Map of Citclops observations
Source: http://www.citclops.eu/

2.6 What are the most important environmental Citizen Observatories in Europe?

The European Union supports the establishment and operation of COs, which are considered supplementary to the long-range satellite technological systems and scientific programs for the observation of the usage and quality of the environment. Apart from the basic data collected through them,

much importance is also attached to the further data collected in situ by the observations made by citizens themselves through COs and the crowdsensing services they possess, strengthening global databases and the potential for assessment, prevention and handling of situations. (Montagril & Santos, 2017).

In recent years, a series of COs has been established across Europe, mainly within the framework of projects funded by the European Commission (EC). For instance, in an attempt to strengthen European citizens' ability to participate in the observation of the environment, the EC supports, through the Seventh Framework Project, the following five projects: Citclops, CITI-SENSE, COBWEB, OMNISCIENTIS and WeSenseIt. Through these, corresponding COs with a clear environmental orientation have been established. However, the serious issue of continued CO operations when funding expires remains. The cost of maintaining and developing the services provided is somewhat high, and often as a result of this, the end of funding results in the suspension of their operations.

Further down, we present more information on these five COs:

The CO established within the framework of the OMNISCIENTIS project works to combine citizens' active participation with the application of innovative technologies, having the aim of improving the handling of unpleasant scents. This type of pollution is not easy to monitor or manage, since its perception has to do with a human sense, smell, and presents a significant level of subjectivity. The monitoring projects was carried out in three locations (Brussells, Virton, and Angiers), in communities close to activities that produce odours (from industry, agriculture, sewage treatment and chemical installations). Participants had access to an online form, in which they reported their perceptions on the type of odour (on a nominal scale with five categories), the intensity of the odour (on a three-point scale), and the degree of unpleasantness they suffered (on a four-point scale). They also reported the location, date, and time of the observation. A mobile phone application developed for this purpose (OdoMap, https://apkpure.com/odomap/com.spacebel.odoMap) (see Image 2) was used in order to enable the participants to report their impressions of odours, using a procedure similar to that on the website (Liu et al., 2017; Montagril & Santos, 2017). The coordinating body for this project and the CO was the Belgian company Spacebell SA, with the participation of Odometric SA (Belgium), KKT-IMA SARL (France), APS Technology SCRL (Belgium), the University of Liège (Belgium), the Graz University of Technology (Austria), BURGO Ardennes SA (industry - final users, Belgium), the Inter-Environnement Wallonie (NGO - final users, Belgium) and the Public Research Centre Henri Tudor (Luxembourg) (OMNISCIENTIS, n.d).

COBWEB (Citizen Observatory WEB) is a citizen observatory established by a partnership led by EDINA, the UK's National Data Centre, which is owned by the University of Edinburgh (Liu et al., 2017). The other participants of this joint partnership were: from Germany, the Dresden University of Technology and the company Secure Dimensions GmbH; from Holland, the company GeoCat BV; from the United Kingdom, Aberystwyth University, the Ecodyfi organisation and Environment Systems Ltd; from Ireland, the University College Dublin; and from Greece, the University of Patras and OikoM Environmental Studies Ltd (OIKOM). COBWEB allows other institutions or organised groups to undertake Citizen Science research using Android mobile devices. With this aim in mind, a series of software applications have been developed, to support the development of a questionnaire, the realisation of research, the storage of data, and the visualisation of data from georeferencing.

Thus, a group of people who wish to carry out a study in a particular field of Citizen Science may make use of the software resources available through COBWEB.

On a trial basis for its research, the project was supported by cooperation with UNESCO's Network of Biosphere Reserves; however, the software and applications are available to any user who wishes to test their idea and develop their own research. COBWEB has also developed a collection of tools that can be used by other COs and Citizen Science projects for the development and management of their own researches.

The Citclops project aims to develop a CO based on Citizen Science applications for the bio-optical observation of coasts and seas (http://www.citclops.eu) (see Image 7).

Image 8: Presenting CITI-SENSE's activities to students in Ljubljana
Source: http://www.citi-sense.eu

This allows the classification of natural waters (rivers, estuaries, coasts, open sea etc.). Using EyeOnWater, a geographical application for mobile phones

(http://www.eyeonwater.org) the user can take photographs, pointing the camera at the surface of the water while following a few simple rules. The user takes a photo, selects the correct colour of the water from a scale, according to their own impression, and then submits the information. The system later automatically calculates, from the image, an FU index value (an indicator of the level of microscopic plant life, sediment and dissolved organic material in the water). Access to the data deriving from the users' measurements can be found at www.eyeonwater.org (Liu et al., 2017: Montagril & Santos, 2017). This project is the result of joint action, with the participation of partners from academic institutions and technology centres (BDIGITAL - Spain, CSIC - Spain, UNIOL - Germany, NIOZ - Holland and VU-VUmc - Holland), industry (Kinetical -Spain, TriOS, MARIS - Germany and NOVELTIS, France) and end-user organisations (TCD-Coastwatch - Ireland and Deltares, Holland) (Citclops, 2020).

The CO created by the WeSenseIt project emphasises the ability off citizens actively involving themselves in data collection, evaluation and communication with regard to the marine environment, including flood danger (https://www.wesenseit.com/). It is the product of joint action headed by the University of Sheffield, with the participation of Hydologic Research (Holland), the IHE Delft Institute for Water Education (Holland, affiliated with UNESCO), the Disdro company (Holland), the Starlab company (Spain), and the water supply company Delfland Water Authority (Holland) (WeSenseIt, 2020).

WeSenseIt allows users (i) to share information before and during floods (such as flood warnings or roads closed by flooding), (ii) to access information on these matters shared by other users, and (iii) to access regularly updated information gathered by sensors.

While the aforementioned COs may be considered as oriented towards the observation of natural resources, WeSenseIt focuses on the management of dangers and urgent needs This may well be accompanied by a different evaluation, on the part of users, of the value of the data, depending on the frequency of the untoward events. The project chose to focus on three case studies, one in Doncaster (United Kingdom), the second in Delfland (Holland), and the third in Vicenza (Italy).

Through an android application, users can share information with regard to (i) floods and flood hazards, (ii) community life, and (iii) the sensors. The sharing of the information takes the form of a report, and after users complete a form on which they give the title of their report, they provide a brief description, assign a category to the report (closed road, closed bridge, etc.), note the date, time and location of the event, and may also include a photograph or a URL address. If users choose to share information under the selection "Community life", they

will have access to a form for the sharing of a post within the application, with fields for the title, description, date, time and location.

WeSense thus allows the filing of data from two different sources: One, from sensors, and two, from the forms that users can utilize to describe an event. Both may be considered objective measures, as the form does not include questions on the users subjective impressions (such as the perception of danger that might follow a flood warning). Rather, it attempts to evaluate objective variables. WeSense also uses social media (Facebook and Twitter) for the propagation of data and the participation of the community.

CITI-SENSE aims at empowering citizens to take part in environmental governance by developing various services in support of COs for the measurement of air quality, both in outdoor spaces and indoors in schools, and for the perception of the environment in public places (http://www.citi-sense.eu).

The project included pilot schemes in eight cities (Barcelona, Belgrade, Edinburgh, Haifa, Ljubljana, Oslo, Ostrava and Vienna). However, it also permitted users in other locations to use the available applications and access data. CITI-SENSE provides the possibility of monitoring air quality by means of a personal toolkit, which comprises of (i) a portable sensor unit (measuring temperature, relative humidity, nitric oxide, nitrogen dioxide and ozone, georeferentially), (ii) an Android application that connects to the sensor unit, allowing the reading of data and their transfer to the server, and (iii) a computer application for the control of the sensors.

Image 9: Smartphone application for the measurement of air quality
Source: Williams, R. (2015) Air Quality Monitoring for Citizen Science (https://www.niehs.nih.gov/research/supported/translational/peph/podcasts/2015/may22_air-quality/index.cfm)

A user may, for instance, carry the sensor unit attached to a jacket or a belt. The user's Android smartphone can then connect to the sensors through

Bluetooth, read the data, and store them on the CITI-SENSE platform. The measurements give an indication of the levels of air pollution and provide information about any changes, even though the measurements are not compatible with those previously carried out by the authorities (Liu et al., 2017, Montagril & Santos, 2017). CITI-SENSE is a joint action by 29 partners (complete list can be found at: https://co.citi-sense.eu/TheProject.aspx). The CITI-SENSE CO gateway at https://co.citi-sense.eu/ is designed not merely to allow citizens to have access to environmental data in real time, as provided by a large number of inputs from applications and sensors (including both portable and static sensors, applications on mobile 'phones, and various studies of perceptions of air pollution), but also to provide a forum for discussion and common use of individual observations.

The above five projects were designed independently from one another. However, they have important similarities as to their structure, function and methodology in relation too their communication with citizens. Additionally, there was cooperation between them in (a) the facilitation of the exchange of data, knowledge and success stories, and (b) the establishment of common methodologies and models for crowdsourcing (Liu et al., 2017, Montagril & Santos, 2017).

To sum up…

In this second chapter of the book, an attempt was made to link Citizen Science with COs, focusing on environmental protection. The ways in which Citizen Science can contribute to environmental protection, and particular with regard to monitoring biodiversity, was explored. The concept of COs was defined. Furthermore, a review was provided of their basic aspects and characteristics. Additionally, the relation of COs and the fields of applications with Citizen Science was examined. Finally, a selected presentation of certain established COs operating at a European level was provided.

Why is biodiversity monitoring central to citizen science?

The term "biodiversity" refers to the variety of life forms on Earth. The term covers "all organisms, species and populations, the genetic diversity among these, and the complex assemblages of communities and ecosystems" (UNEP, 2010). The value of biodiversity is immense and multi-dimensional, and has been much studied. Specifically, the individual components of biodiversity - genes, species and ecosystems of direct, indirect or potential use to humanity, which are referred to as "biological resources" – offer a

wide range of benefits and facilities to society. Examples of such cases are hybrids used by agriculturalists for the development of new crop varieties, species used in various foods, medications and industrial products, and ecosystems that provide such benefits as water purification and flood control (National Research Council, 1999).

However, in our times, biodiversity faces some very serious threats and pressures, with about one species in four in danger of extinction. Various human activities constitute serious threats to a large number of species, endangering biodiversity, as shown in Figure 4.

More specifically:

• There are many factors that may threaten terrestrial biodiversity, such as changes in the use of land, habitat disturbance, intensive exploitation, invading species, ground compression, erosion, and pollution.

• As for drinkable water, the poor ecological state of many freshwater ecosystems is a cause of global concern, since these systems contribute to ensuring the availability of clean water, which may face shortages in the future.

Image 10: "Biodiversity" expresses the variety of species on Earth
Source: Pacific Islands Protected Area Portal
(https://pipap.sprep.org/news/biodiversity-loss-loss-humanity)

• Marine biodiversity is another vital sector, connected with exploitation of fish stocks, food chains, and the integrity of the deep seas.

• Agrobiodiversity may be threatened by the increasing intensity of farming practices (increased use of agrochemicals, simplification of crop rotations, increasing the cultivated area, deterioration the natural features of the locality, etc.), as well as by neglect of the land. Specifically worries about the conservation and quality of agrobiodiversity have been among the concerns of the Common Agricultural Policy (CAP) since the early

1990s, that aims to mitigate the consequences of the factors that cause its loss. Moreover, it has set as an aim that the agricultural industry should be advised on the preservation of biodiversity and the important services offered by ecosystems (such as pollination, control of parasites and limitation of erosion), while at the same time reducing certain negative consequences (washing away of nutrients, emissions of greenhouse gases, etc.).

• Reductions in woodland biodiversity leads to losses in the productivity and viability of woodland ecosystems. Woodland ecosystems cover almost 40% of Europe's surface. Apart from providing wood, woodlands offer many benefits for climate control, human health, recreation, fresh water resources and biodiversity pools. Woodland ecosystems and the biodiversity of species that develop inside of them are interconnected; biodiversity is, to a great degree, dependent on the integrity, health and vitality of wooded areas. Sustainable woodland management, therefore, aims to support the provision of woodland goods and services and to increase levels of biodiversity

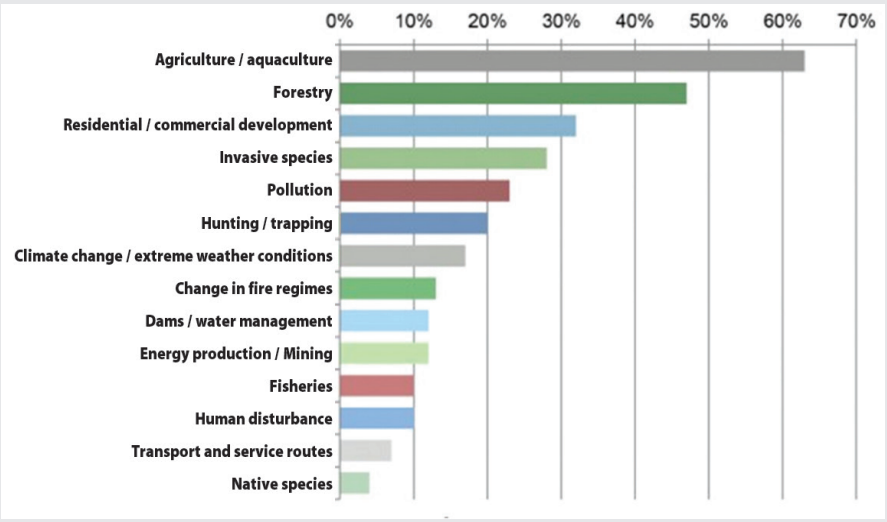

Table 2.4: Main biodiversity threats and percentages of threatened species
Source: (UNEP, 2012, pg. 139).

• Invasive species are another cause for concern. Human activities, such as shipping, aquaculture, the construction of canals and trade, have removed some of the natural barriers between bio-communities, allowing species to subsequently enter regions to which they are not indigenous. Europe

is greatly afflicted by such biological invasions, which are considered one of the most significant direct factors in loss of biodiversity, and place great strain on various kinds of ecosystems, with both ecological and economic repercussions.

In Table 1, below, an overall picture is provided as to the pressures and threats to biodiversity in Greece.

Pressure-threat category[59]	Number of species							
	Plants[60]	Birds[61]	Amphibians[62]	Serpents[63]	Land mammals[63]	Sea mammals[63]	Sea fish[63]	Freshwater fish[63]
1. Residential expansion. Industrial and tourist development								
Residential expansion and industrial development	6	60	6	6	14			26
Development of coastal tourist infrastructure	33	30	5	5	2	1		
Development of non-coastal tourist infrastructure	11				13			5
2. Agriculture, fishing and aquaculture								
Expansion and intensification of agricultural crops	16	89	7	6	9			
Woodland plantations		11		3	6			
Livestock (over-grazing)	50	39	1		2			
Aquaculture (sea)		4				1		
3. Energy production and mining								
Mining	11	16	1	2	2			3
Energy production from renewable sources (non-hydroelectric)	17[64]	23						
4. Transport, energy and telecommunications networks								
Roads	21	45	1	8	13			
Energy and telecommunications networks		23						

Table 1: Pressures and threats to biodiversity in Greece (YPEKA, 2014, pg. 54)
Source: YPEKA, 2014, pg. 54

Protected natural areas are an essential condition for the conservation of biodiversity and ecosystems, so their extension is a central aim not only of the European Union but also of the United Nations They are, moreover, of particular importance in developing countries, where the population is highly dependent on natural resources. The international community has committed itself to the protection of at least 17% of land area and inland waters, and 10% of coastal and sea areas by 2020 (Joint Research Centre, 2015).

The range and variety of threats and pressured that biodiversity faces in the present make monitoring and recording a necessity, to swiftly identify the changes that are occurring as a result, and to plan relevant interventions.

Finally, it is worth noting that this monitoring/recording of biodiversity functions as an indicator of environmental quality, and is also useful in the observation and prediction of the evolution of climate change. For these reasons, Citizen Science has positioned biodiversity among its central objectives, while its monitoring and recording is one of the most frequent fields of application for Citizen Science (See Image 11) Existing and planned projects in many COs, and the results of their trial runs, demonstrate that they have the potential to complement official networks for the local observation of biodiversity and contribute to European measures and policies, in sectors that range from water management and the protection of air quality, to the preservation of endangered species or the observation of climate change (Liu et al., 2017).

Image 11: Citizen Science supports oceanographic research projects that help enrich our understanding of the world's oceans, through technological innovations, smart observation and analysis, and an open exchange of information (World Ocean Observatory, 2019).
Source: World Ocean Observatory, 2019

In Greece, there is the Hellenic Biodiversity Observatory (EPB) https://www.biodiversitygr.org. The idea behind it was the ability of voluntary participation of not only of scientists but also of citizens, who can provide data and information near their homes. It is worth noting that the EPB deals with the observation and recording of all species and not only some specific species (ex. endangered species). The following are listed as the objectives of the EPB (Hellenic Biodiversity Observatory):

- Conservation of wildlife and biodiversity
- Observation and recording of biodiversity
- Care for and reintegration of wild animals into the environment, and
- Promoting ecological awareness towards wild creatures and Greece's environment.

Four of the largest COs for biodiversity participate in the European project Cos4Cloud: Natusfera https://natusfera.gbif.es), iSpot (https://www.ispotnature.org), PlantNet (https://plantnet.org/en) and Artportalen (https://www.artportalen.se) (CREAF, 2020).

Some other biodiversity COs that focus on flora, forests, mountains, the biosphere, and trees are:

•PlantWatch https://www.naturewatch.ca/plantwatch in Canada, which allows citizen scientists to participate by recording flowering times for selected plant species and reporting the dates of the recordings to researchers working to identify ecological changes that may affect the environment (Naturewatch, 2020).

•LeafWatch https://gastateparks.org/LeafWatch is directed at residents of the U.S. State of Georgia, and invites them to visit and photograph the Georgia's state parks. The best photos are displayed on the abovementioned website, but citizens are also encouraged to upload and share their photos and stories to the Georgia State Parks' Facebook and Instagram accounts, as well as on Twitter, under the hashtag #GaLeafWatch (Georgia Department of Natural Resources, 2020).

•MountainWatch https://scistarter.org/mountain-watch is one part of the ongoing South Carolina project of the same name, which monitors seasonal plant growth (known also as phenology) of a small set of alpine and forest plants in the Eastern Appalachian Mountains and other north-eastern regions of the U.S.A. (SciStarter, 2020).

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CHAPTER 3

THE EUROPEAN COS4CLOUD PROJECT.
ADDRESSING THE CHALLENGE OF OPEN SCIENCE FROM THE STANDPOINT OF CITIZEN SCIENCE

Maria Daskolia & Maria Pliota

3.1. What is ''Open Science''?

One of the dimensions that Citizen Science has been linked to in the 21st Century is that of ''Open Science'', otherwise known as ''Science 2.0''. According to the European Union (2016) the concept of ''Open Science'' comes in response to the request for the creation of a dynamic democratic environment for organizing, conducting and making publicly available scientific research, which gives access to all stakeholders and anyone else who might be interested, to the data, processes and results of each individual research project or the totality of research in the various scientific fields.

The ultimate goal of «Open Science» is to make the whole cycle of scientific research «open», from the conception of a research idea to the communication

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of research results. Supported by the new digital technologies and tools, a new environment is created that strengthens and facilitates interaction between researchers and the continuous sharing of scientific knowledge. Access to publications and research data, all of which in digital form, is free with no, or minimal restrictions (''Open Access''). Also becoming freely accessible are the funding mechanisms (e.g. through crowdsourcing platforms), electronic databases (e.g. with data repositories, digital libraries, etc.), and open peer review systems etc. And so the established practices of publishing research results after completion of the research process are inevitably being abandoned.

Among the eight priorities set out in the HYPERLINK «https://research-and-innovation.ec.europa.eu/strategy/strategy-2020-2024/our-digital-future/open-science_en» European Union's Open Science Agenda are the creation of the HYPERLINK «https://eosc-portal.eu/» European Open Science Cloud and the promotion of the HYPERLINK «https://www.go-fair.org/go-fair-initiative/» FAIR Data Initiative.

The European Open Science Cloud, EOSC, is an ambitious project of the European Commission, that aims to promote international recognition and maintain the leadership role of science conducted in Europe through the creation of a reliable digital environment for hosting and processing research data and results. This goal will be achieved by developing a world-class scientific infrastructure from which European scientists and other stakeholders will reap the benefits of science in the digital economy and wider community.

The ''Cloud'' will offer 1.7 million European researchers and 70 million professionals in science and technology a virtual environment with open and seamless services for storing, managing, analysing and reusing research data, in distinct scientific domains and interdisciplinary fields. All these services will be free of charge.

Image 1: The Logotype of the European Open Science Cloud
Source: https://eosc-portal.eu/

The FAIR Data (Findable, Accessible, Interoperable and Reusable Data) initiative is a bottom-up approach, that aims to implement the principles making data findable, accessible, interoperable and reusable. It offers an open and inclusive ''ecosystem'' for individuals, institutions and organisations working

together through Implementation Networks - INs. The INS are active in three activity pillars: GO CHANGE, GO TRAIN, and (GO BUILD).

3.2 What is the relationship between Citizen Science and Open Science?

Together with the creation of the European Open Science Cloud and the FAIR Data Initiative, Citizen Science is also one of the eight priorities of the EU Open Science Agenda. Over the last few decades, Citizen Science' contribution to scientific research has escalated, thanks to the use of digital technologies. Millions of data are collected worldwide every year through the Citizen Observatories (COs), thus contributing not only to research but also to policy-making. (Bio Innovation Service, 2018).

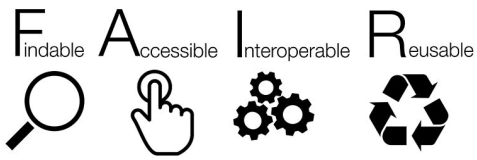

Image 2: The logotype of the FAIR Data initiative
Source: www.go-fair.org

The concept of "Open Science" has a particular grounding in the attempt to reshape the prevailing culture surrounding scientific research, which either does not recognize, or considers of secondary importance, any other ways of producing knowledge other than that of traditional science - and the same applies also to the general public's engagement in it. However, as noted in the announcement of the 3rd UNESCO Environment Conference (UN Environment Assembly, 2019): «Traditional science cannot provide all the information on its own, nor at the required level for understanding environmental changes". Conversely, Citizen Science offers many distinct advantages, such as the fact that it encompasses different types of knowledge and promotes collaborative intelligence and co-creation in finding community-based scientific solutions. In addition it attempts to create connections between science and education, which when combined with new and emerging technologies overcome the geographical, thematic or even linguistic "boundaries" to doing scientific research and the public's engagement therein. Finally, the recent development of Citizen Science has given rise to a variety of approaches, tools, sources, projects and achievements in all scientific domains, the experience of which can be used to the advantage of scientific research and knowledge.

This exponential increase in participants, data and research output from the

Citizen Science area accounts for more than 50% of the data available on the Global Biodiversity Information Facility – (GBIF) and has generated a significant number of observations relating to environmental monitoring (for the air, water, noise, odours, climate, etc.). All the above pose many, large-scale challenges for the COs, which will need to facilitate not only efficient data capture, identification and validation, but also the interaction among all parties involved in the Citizen Science processes, based on a model that allows for the transfer of knowledge, as well as stewardship and storage of large volumes of data in different formats.

COs have to ensure interoperability between them at local, national and global level, as well as their sustainability, overcoming any difficulties in accessing data by developing new functionalities using cutting-edge technologies. Hence, the recommendations of the European Commission on Open Science (European Commission, 2018) emphasise the development of infrastructure, formulation of guidelines and specifications and need for providing central networks, that will highlight and promote citizens' initiatives. They will also provide opportunities for collaboration, shared use of tools and exchange of best practices (Bio Innovation Service, 2018).

3.3 What were the vision, objectives and lines of action of the European Cos4Cloud project?

As already mentioned in the previous subsection, together with the creation of the European Open Science Cloud, and the FAIR Data Initiative, Citizen Science is one of the eight priorities of the EUA Open Science Agenda (European Commission, 2018). It is within this same context that the European Cos4Cloud project (full title: "Co-designed Citizen Observatories Services for the EOS-Cloud") attempted to act and respond. This was a research and development project (R&D) that was submitted as a proposal, evaluated and approved for co-financing, by the European Union's Horizon 2020 Project.

The 40-month Cos4Cloud project started in November 2019 and finished in February 2023. Its main goal was to develop new services for Citizen Science' core structures, the Citizen Observatories (COs). These services complement, improve and upgrade the operation of the COs and are available to both the European scientific community and to all volunteer scientists taking part in Citizen Science projects and actions as CO users.

More specifically, the vision that the Cos4Cloud project set and attempted to serve was to integrate Citizen Science into the European Open Science Cloud by co-designing innovative services that respond to a number of challenges faced by the COs in relation to the Citizen Science services they offer to the scientific community and society. The project built on the digital infrastructures and services provided by some of the existing COs in Europe and enhanced them

with new, state-of-the-art services, in an effort to strengthen the presence and role of the COs and ensure that not only are they sustainable but that their field of activities continues to expand at a global level. These new services that were co-designed by various actors participating in the CO processes, and which were developed and tested during the project, appear in the form of a ''menu" of functions so that each new or existing CO can select and install the ones it needs.

Image 3: The logotype of the European Cos4Cloud project
Source: https://cos4cloud-eosc.eu/

The objectives of the Cos4Cloud project were to:

1. Integrate Citizen Science into the European Open Science Charter through the development of a ''Minimum Viable Ecosystem" for the Citizen Observatories and to integrate it into the European Open Science Cloud hub.
2. Co-design, prototype and implement innovative services for the Citizens Observatories, based on the architecture for federated structures, to help address the challenges faced by COs, focusing on interoperability and innovative models of collaboration, aimed at serving all Citizen Science stakeholders, from professional scientists and citizen scientists to government representatives, industry and entrepreneurs.
3. Increase the quantity and quality of the available data coming from Citizen Science following the FAIR Data Initiative principles.
4. Make available to the Citizens' Observatories, user-friendly horizontal services supported by and leveraging artificial intelligence, automated information extraction, recognition and visibility of data contributors, visibility of data, validation and integration using information in different fields (biodiversity, air quality, water quality).
5. Facilitate networking and knowledge management processes across organizations, people and initiatives in the context of the COs by designing tools, access mechanisms and interfaces based on collaborative design methods, Open Science recommendations and EOSC guidelines.

Specifically, thirteen new technological services were designed and developed, to ensure interoperability and data security. They were based on open specifications and are user-friendly. The objective was for anyone interested to be able to reuse the data collected from different Citizen Science projects and activities over and over again for research, innovation and educational purposes. Taking into account the scale of the partnerships supporting the various COs in different fields of research, the designed services may end up serving several thousands of their users, not only in a pan-European community, but stretching also to a global, scientific albeit non-academic one.

Image 4: Recording observations with Natusfera app
Source: Cos4Cloud

One of the services that were designed was a portal integrating all the observations and data collected from the different science-related COs and citizen science platforms focused on biodiversity and environmental monitoring. Other services include a range of artificial intelligence tools that will help citizens identify, for example, flora and fauna species when they observe or send their observation, thanks to confirmation through the corresponding data collected from different platforms or recorded in the relevant data bases. This service was already being used on Citizen Science platforms and related projects. One such case is Pl@ntNet, which was also one of the partners and COs in the project. As explained by Alexis Joly, researcher at INRIA and member of Pl@ntNet's design team, ''in the Cos4Cloud project, in addition to making this technology available to other Citizen Science projects, we want to go one step further, and suggest, through this technology, the species that one can expect to find and/or find in a certain area".

It was also planned to improve the quality of the data and related information from Citizen Science projects and actions by establishing a common vocabulary, also in the context of machine learning, with services encompassing automatic video recognition and creation of advanced mobile application interfaces as well as new models and protocols validated by traditional science. The new services ensure the visibility and recognition of the input from the data contributors and

improve networking between various participants – partners. In the long term, all these services will be used also by other COs and Citizen Science projects operating in thematic areas, (other than the environment), such as health.

Services that were developed within the context of the Cos4Cloud project:

- A portal that will gather, and provide access to, observations/data from different Citizen Observatories
- Use of artificial intelligence for species recognition/ identification
- Facilitation of AI knowledge by leveraging observations from different Observatories
- Access to large-scale data bases (e.g. Pl@ntNet)
- Estimate/prediction of the presence of species based on location
- Facilitation of analysis and visualization of citizen-sourced data (Python - based)
- Development of user/citizen-friendly interfaces for data collection through sensors on smartphones
- Assistance of automated species recognition from camera trap images
- Identification system that allows citizens to find out how scientists use their observations
- Video stream processing service

Text Box 3.1: Cos4Cloud services

Some anticipated positive effects of the Cos4Cloud project

- Open Science goals supported through improved access to content and resources and facilitation of interdisciplinary collaborations
- Enhanced position of Citizen Science in the scientific community
- Improved citizen science ecosystems; increased quantity and quality of available citizen science data
- Stable, reliable, user-oriented environment for citizen-scientist volunteers
- Monitoring of access to, and reuse of, data in research, industry and governance

Text Box 3.2: Anticipated positive effects of the Cos4cloud project

3.4 Who were the contributors of the Cos4Cloud project?

The COs4Cloud project was implemented by a team of partner organisations with significant experience in implementing Citizen Science actions and who have led large-scale projects in this field. More specifically, the project team consisted of 16 Partners from 7 European countries and 1 Latin American country.

Image 5: From Cos4Cloud's kick-off meeting (November 2019). Photo: Cos4Cloud's team.
Source: Cos4Cloud

The project was coordinated by the Consejo Superior de Investigaciones Cientificas (CSIC) (Spanish National Research Council) and, in particular, by the Institute of Marine Sciences (ICM). Spain participated in the project with 3 more partners: the research centre CREAF (Centre for Research on Ecology and Forestry Applications) and IFCA-CSIC (Institute of Physics of Cantabria - Consejo Superior de Investigaciones Científicas), the NGO Science for Change and the web technology development company Bineo Consulting.

Universities, research centres, NGOs, agencies and companies from different European countries formed an interesting mosaic, and offered rich experience and knowledge from different perspectives. Participating from the United Kingdom were the Open University, the NGO Earthwatch and app development company DynAIkon. From France, the INRIA research centre and from Sweden the Swedish University of Agricultural Sciences. From the Netherlands the Dutch company DDQ and from Germany the NGO 52°North, and the company Secure Dimensions. Europe was represented in the project by the European Citizen Science Association (ECSA) and participating for Colombia was the NGO Trébola. Representing Greece in the official project team was the National and Kapodistrian University of Athens through the Environmental Education Lab (EEL).

An important part of the dynamics of the Cos4Cloud project lied

precisely in this interdisciplinary and international collaboration, since in the implementation team experts from the field of Citizen Science, service designers, companies, researches and scientists all joined forces.

3.5 Which Citizen Observatories have participated in the Cos4Cloud project?

COs4Cloud was based on the participation of a network of 9 Citizen Observatories focusing on biodiversity and environmental monitoring. These platforms were responsible for testing the various services developed within the project, and for their evaluation by the end users.

The first part of the project focused on four of the largest citizen biodiversity COs: Natusfera, iSpot, PlantNet and Artportalen. In the second part, the services developed were tested on CO platforms focused on environmental quality. Specifically, the participating observatories were: Freshwater Watch and KdUINO, focusing on water quality monitoring, OdourCollect, focusing on odour pollution monitoring, CanAir.io, focusing on air monitoring and iSpex, focusing on aerosol monitoring.

Examples of 4 of the COs participating in the project are given below: biodiversity observatories iSpot, Natusfera and PlantNet and environmental monitoring observatory OdourCollect.

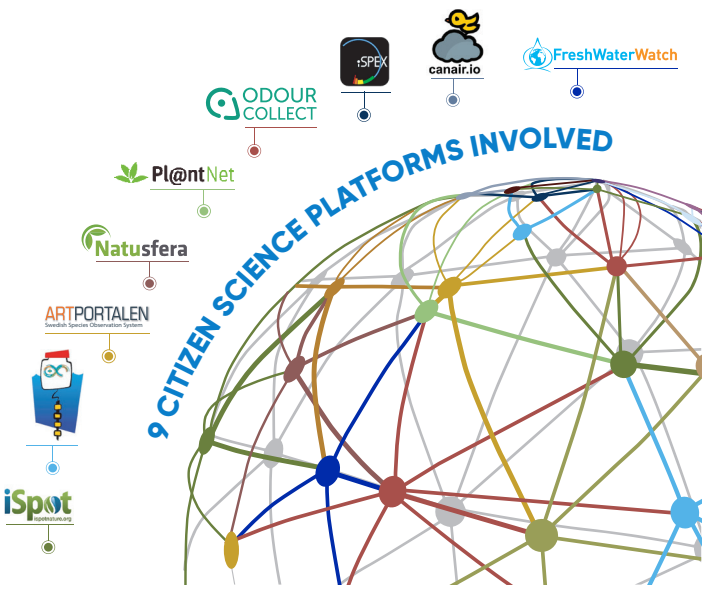

Image 6: The nine citizen observatories involved in the European Cos4Cloud project
Source: Cos4Cloud

iSpot is one of the most well-known CO platforms on biodiversity monitoring. It encompasses a network of over 68,000 volunteers, scientists/nature observers worldwide, who have identified around 30,000 species, through over 1,500,000 images of more than 750,000 observations of different species of flora and fauna.

Anyone can join and participate in the iSPot community by sending photos of:

- birds
- amphibians and reptiles
- fish
- fungi and lichens
- invertebrates
- mammals
- other organisms
- plants

iSpot has been integrated into the curriculum, including modules and lessons, of the Open University in the UK, facilitating informal and non-formal learning in science, through Open University-BBC co-productions and free learning resources

iSpot data is also a research-grade tool for investigations on biodiversity, making an important contribution to national strategy and policy in associated areas. For example, iSpot was part of a partnership initiative, funded by Defra, to define a National Pollinators Monitoring Scheme. Additionally, the value of citizen science through tools like iSpot is explicitly mentioned in the 2011 Government White Paper on the environment in the section on 'Reconnecting people and nature' and the OU, through iSpot, is a Royal Society for the Protection of Birds (RSPB) partner.

Language:	English
Geographical coverage:	international
Coordination and funding:	Open University (United Kingdom), since 2009.
Website:	www.ittps://wwspotnature.org
User registration page:	hw.ispotnature.org/register

Natusfera

Natusfera is one of the largest CO platforms in the biodiversity domain. Its main objective is to share knowledge about biodiversity with the whole volunteer-citizen community that it has created, through their recordings of different species of living organisms on the relevant app. More than 13,000 citizens have participated, contributing over 240,000 observations to Natusfera.

As in iSpot, citizens can participate in Natusfera by sending photos of:

- birds
- amphibians and reptiles
- fish
- fungi and lichens
- invertebrates
- mammals
- other organisms
- plants

Natusfera is a digital space where, after registering the user can then organize and share photos of all kinds of biodiversity observations. It is a sort of 'virtual field notebook' that allows users to keep their observations in the cloud, connect and talk with other citizens/users, who can help in identifying the photographed species. It is also possible to collaborate in various projects as well as create new ones at any geographical scale (e.g. for invasive species, lichens, marine biodiversity, etc.).

Natusfera has been adopted as the Citizen Science platform for the Spanish node of the Global Biodiversity Information Facility (GBIF), which also covers its basic operating costs.

Languages:	English, Spanish, Catalan, Galician, Basque, Italian
Geographical coverage:	local, national, pan-European, international
Coordination and funding:	Started out in June 2016. Coordinated by a consortium of organizations among which three are Cos4Cloud partners: CSIC, CREAF and Bineo.
Website:	https://natusfera.gbif.es/?locale=en
User registration page:	https://natusfera.gbif.es/signup

Pl@ntNet

Pl@ntNet is a participatory Citizen Science platform for collecting, sharing and reviewing plant observations based on automated identification. It aims to to monitor plant biodiversity and facilitate access to plant knowledge by the general public.

The platform's website and smartphone app are used by a large community of several million citizens who produce hundreds of thousands of plant observations daily. This data stream is of high interest for many research domains, including ecology, agronomy and energy.

Among other features, this free mobile app helps identify plant species from photos using visual recognition software. This means that the user can send an image of any plant and through the app get help in identifying the species thanks to artificial intelligence. At the same time the Pl@ntNet app improves its performance with every new observation (new species, new data, higher quality, etc.).

Confirmed observations are integrated into the Global Biodiversity Information Facility (GBIF), the world's largest international repository of biodiversity. Pl@ntNet's data and mode of operation are of great interest to an increasing number of researchers and Citizen Science stakeholders in various domains (data science, ecology, biodiversity, phenology, plant health etc.).

Within a few short years Pl@ntnet has turned into a Citizen Science "ecosystem" with millions of registered users and tens of thousands of active users.

Language:	French, English (smartphone app available in many other languages including Greek)
Geographical coverage:	local, national, pan-European, international
Coordination and funding:	Pl@ntNet is an open consortium currently including 4 French research organizations (CIRAD, INRAE, Inria and IRD) and the Agropolis foundation
Online version of the app:	https://identify.plantnet.org

OdourCollect is an app that any citizen can use to report incidents of environmental pollution detected and identified on the base of bad odours. It is a participatory tool to empower citizens and local communities affected by odour to report such cases to the rest of the world.

The app aims to create "odour maps" based on the observations of different citizens. Anyone can take part by reporting bad odours with the goal of co-creating solutions with all the stakeholders involved (citizens, industries, local authorities, experts), to improve the quality of life of a community. Odour observations can be validated by experts to gather data in a particular area, where a community is affected by this problem. The ultimate goal is co-designing local solutions with relevant stakeholders.

Any citizen can act as an observer and report geo-located observations on an odour episode, which are open data and can be used to build collaborative odour complaint maps, report complaints and identify their emission sources. Odour pollution is the second reason for environmental complaints in across Europe, after noise. Frequent and continued exposure to odours can cause headaches, stress and respiratory problems. Unusual and unpleasant odours can also be a sign of greater environmental problems, such as poor waste management or contaminated water.

OdourCollect has been implemented in 10 pilot projects in different countries, under the European D-Noses project (Spain, Chile, Greece, Portugal, Germany, UK, Bulgaria, Italy and Uganda).

Languages:	Spanish, English, Catalan, Portuguese, German, Italian
Geographical coverage:	local, national, pan-European, international
Coordination and funding:	The first version of OdourCollect was developed by Science for Change and produced within the framework of MYGEOSS, a two-year (2015-2016) EU project for developing smart Internet applications GEOSS (Global Earth Observation System of Systems), informing European citizens on the changes affecting their local environment.
Website:	https://odourcollect.eu

3.6 What were the fields of action and initiatives promoted by the Environmental Education Lab (NKUA) through the Cos4Cloud project?

The Environmental Education Lab (EEL) (URL: http://eel.eds.uoa.gr/) is part of the Department of Educational Studies the Faculty of Philosophy of the National and Kapodistrian University of Athens (NKUA). It was established in 2004 (ΦΕΚ 221/τ. Β'/18.02.2005) by the Department of Philosophy, Pedagogy and Psychology as an administrative and scientific development of the former Environmental Education Centre (ECE). As an academic research unit it carries out research, educational, training, developmental, advisory and social work in Environmental Education (EE) and Education for Sustainable Development (ESD), serving the following purposes:

- Development of research, academic cooperation and scientific activity in the field
- Education of undergraduate and postgraduate students
- Initial and in=service training of teachers
- Environmental information and communication, awareness-raising and capacity-building of the general public
- Scientific support of the educational work and expert advice and consultation to institutions, organisations, individuals and teams
- Development of partnerships and sharing of experience with other institutions, centres, organisations and teams at a national, European and international level
- Contribution to networking and creation of communities of learning and practice between individuals, groups and organisations
- Development of printed and digital educational material in the context of formal, non-formal and lifelong learning
- Contribution to the dialogue for the formation of national and European education policy on R&D issues and development in EE and ESD.

The EEL's scientific team consists of its Director, Dr. Maria Daskolia, Associate Professor of Environmental Education at the Department of Educational Sciences, other collaborating teaching and research staff of the Department, teaching and research staff of other Departments and Universities, PhD holders and doctoral students of the Department, qualified laboratory staff as well as teachers who are specialized and have experience in EE/ESD.

To date, EEL has coordinated or participated in the implementation of 11 European and national research projects. EEL has participated in the European

Cos4Cloud project as a national partner, having been tasked to design and implement actions that will contribute to connecting Citizen Science and the COs participating in the project with the school community, in Greece and at a European level, through Environmental Education/Education for Sustainable Development (EE/ESD).

In this context, the EEL EEL carried out a series of actions, namely:

- Training the main educational stakeholders as regards Citizen Science, the use of the COs' structures and services and their integration in the school practice of EE/ESD in Greece.
- Co-creation of relevant educational material for primary and secondary education schools
- Collaboration with education officials and teachers for the design and implementation of educational activities /projects in schools
- Collaboration with NGOs and Local Authorities for the planning and implementation of actions in/with schools within the community
- Creation of communities of practice that will enhance the connection with the actions, platforms and communities of the Citizen Observatories participating in the project
- Establishment of school networks at a regional, national and European level
- Research on learning and participation in Citizen Science educational actions in the context of best EE/ESD practices

Among these actions has been the online training course «Citizen Science and Environmental Education for Sustainability» which was hosted on the Eclass platform with the technical support of the Centre for Continuing Education and Lifelong Learning (KEDIVIM) of the National & Kapodistrian University of Athens.

Image 7: Part of the webpage design of the Environmental Education Lab of NKUA
Source: http://eel.eds.uoa.gr/

To sum up…

Cos4Cloud is a European project that promoted and facilitated the integration of the Citizen Observatories within the context of the European Open Science Cloud (EOSC). During the project (2019-2023) a series of actions were carried out aiming at developing and testing a range of tools, new services and activities that would aid and promote the connection of COs to the European Open Science Cloud (EOSC). Among the partners involved in the project, the EEL of NKUA had a distinctive and central role, to contribute to the integration of Citizen Science and COs with formal, school-based education and in particular with EE/ESD practices.

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CHAPTER 4

CITIZEN SCIENCE AND SCHOOL PRACTICE IN THE CONTEXT OF ENVIRONMENTAL EDUCATION / EDUCATION FOR SUSTAINABLE DEVELOPMENT

Maria Daskolia & Naya Grillia

4.1. Where do Citizen Science and Environmental Education for Sustainability converge?

Current environmental problems are complicated social issues characterized by high levels of complexity and ambiguity and correspondingly low levels of sense of certainty and control. This is due to the fact that the reality of their nature, the factors that cause them and the available solutions may all change over time (what holds true today may not necessarily hold true tomorrow), just as the perspectives through which they are perceived may vary depending on the context, situation or individuals involved.

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This inherent "difficulty" of addressing and managing environmental problems requires action at more levels and in more ways. As seen in a previous chapter, Citizen Science recognizes the serious challenges posed by the complexity of today's environmental problems and the need for actively engaging the general public in every environmental protection effort, with Citizen Science itself serving as a tool for knowledge and participation in decision-making for environmental management, at both international and local levels. Through Citizen Science projects and initiatives volunteer/amateur scientists, in addition to contributing to the strengthening of science and environmental research, also enhance environmental governance and feed into environmental policy. This is achieved on the one hand by the environmental literacy they develop and on the other through their bonding more with a place by experiencing it first-hand.

Certainly, Citizen Science is not alone in striving to address the multiple challenges posed by today's environmental issues. Environmental Education (EE) is another field of practice with similar goals. In fact, from the initial steps of its establishment (Stapp et al., 1969, Hungerford, Peyton, & Wilke, 1980, UNESCO-UNEP, 1976; UNESCO, 1978) two essential foci of the definition of Citizen Science have been (Short, 2009): (a) sound, research-based (individual or collective), educational methodologies engaging learners as active participants in learning processes, and, (b) the development of environmentally literate and active citizens, capable of thinking critically about environmental issues, and becoming actively involved in different environmental issues, to work toward improvement of environmental conditions and their quality of life.

Thus the concept of the active and responsible citizen becomes a key feature of EE and a basic tool for its future development as Education for Sustainable Development. According to Jensen & Schnack (1997) cultivating action competence should be the main focus of EE. Similarly, Breiting & Sorensen (1999) underline the importance of this approach, pointing out that it refers to a free action, where direction is not given beforehand and which is based on scientific knowledge and critical thinking, leading to the democratic participation of citizens in solving environmental issues.

In the same line of thought Chawla & Cushing (2007) argue that, ever since the Tbilisi Declaration, the ultimate objective of EE has been people's active involvement in working toward the resolution of environmental problems and all other objectives, (awareness, knowledge, skills, concern for the environment) are ingredients needed to achieve this goal. Short, too, (2009) emphasizes that although "participation" in environmental protection is clearly among EE's goals and one of its inherent characteristics, it is the development of "independent

and thoughful citizens, equipped with the necessary knowledge, attitudes and skills for long-term responsible behaviour" which is the main educational pursuit (Short, 2009, page 11).

Image 1: Education for Sustainable Development
Source: https://www.sdg4education2030.org/education-sustainable-development-goals-learning-objectives-unesco-2017

Education for Sustainable Development, which followed on from EE in the early 1990's, corroborates a similar perspective. With a renewed approach, Education for Sustainable Development (ESD) sets in parallel with the environmental problems also the challenge of sustainability, as a vision and at the same time a new understanding of a way to manage these issues. Dominant here too is the development of active citizen participation through a transformative pedagogy that, «is action-oriented, supports self-directed learning, participation and collaboration, problem-solving, inter- and trans-disciplinarity, as well as the linking of formal and informal learning» (UNESCO, 2019, p. 7). In particular, EAA considers that the complex and pressing challenges of ecological sustainability and social and political stability can be addressed through the development of skills in authentic learning experiences, which engage the learners in issues that concern and trouble them (UNESCO, 2017). For this purpose skills are required that will empower them as active and responsible citizens, who are interested in/concerned about is taking place around them and ready to take initiatives and action initiatives and actions to bring about change.

In line with this UNESCO has been promoting in recent years another another approach which complements that of ESD: Global Citizenship Education (GCED) (UNESCO, 2019). Both «educations», ESD and GCED, are based on three learning dimensions: (a) a cognitive, (b) a socio-emotional, and (c) a behavioural one (UNESCO, 2017). More specifically, the aim is for citizens to acquire experiential and empirical knowledge of their environment, in addition to environmental literacy, through participatory social learning processes, they can be empowered and take action.

To sum up, whether related to the environment or sustainability the current issues of conservation of natural resources, and protection of biological capital and environmental quality that are of concern to contemporary societies, pose challenging problems that are characterized by high levels of complexity, uncertainty and unpredictability. A typical example is biodiversity loss (Dillon, Stevenson & Wals, 2016).

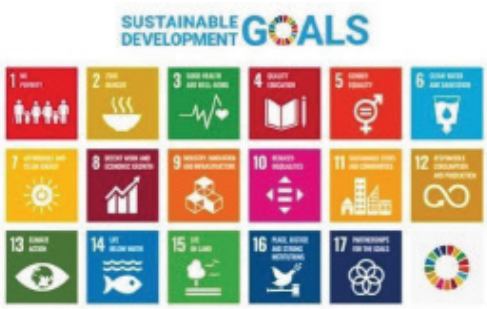

Image 2: 17 Sustainable Development goals
Source: https://unric.org/el

In order for individuals to become agents of change and better address the ambiguity and insecurity inherent in these issues, environmental learning is a central priority, either in the context of formal/school education or through non-formal and informal educational projects. With this type (pedagogical) of interventions experiential knowledge can be developed that will, on the one hand, help bring people into closer contact with the environment, to become more familiar with it and develop a sense of belonging, and on the other hand to understand the various issues in depth and develop a responsible attitude towards them, through participation and assertion (Leicht, Heiss & Byun, 2018).

The 17 Sustainable Development Goals

In 2015, as a result of a three-year process that followed the 2022 United Nations Conference on Sustainable Development, Rio +20, the 2030 Agenda for Sustainable Development was adopted so that the UN member states could use it as a base upon which to formulate their political agenda for the next 15 years. Sustainable Development was once again at the forefront of global discussions, and the 17 Sustainable Development Goals (SDGs) were placed in the spotlight. These Goals address major and critical challenges for the survival of humanity and seek to pave the way towards sustainability, peace, prosperity and equality.

The vision reflected by the 17 Goals has been linked to education right from the start. Education itself was identified as one of the Goals (Goal 4: Quality Education). At the same time, however, a number of indicators are identified across the 17 Goals, which connect with and are based on education, highlighting it as a key means to achieving them. Thus education is not just another goal among the 17. Rather it is considered the key factor contributing to the promotion and stimulation of the vision to take concerted action regarding issues of vital importance for mankind (UNESCO, 2017).

Text Box 4.1: The 17 Sustainable Development Goals

Image 3: Goal 4: Quality Education
Source: https://unric.org/

4.2. What are the common characteristics of Environmental Education for Sustainability and Citizen Science?

Reading carefully how UNESCO (2019) defines Education for Sustainable Development (ESD), i.e. as the continuation and expansion of Environmental Education (EE) with the concept of sustainability at its core, one can understand how much ESD shares with Citizen Science. The two approaches are not only compatible with each other, but also complementary.

As already discussed, the vision of EE and ESD is about developing active and responsible citizens, who are interested in, and understand, the complex issues that concern the world around them and undertake initiatives and actions to bring about changes in these issues in the direction of sustainability. In both its manifestations, therefore, EE and ESD, it is essentially a civic education.

Image 4: Education for Global Citizenship
Source: https://www.un.org/youthenvoy/2016/04/join-66th-un-dpi-ngo-conference-education-for-global-citizenship-achieving-the-sustainable-development-goals-together/

The same applies to Citizen Science. Both the citizen as a concept and education as a process are intrinsic to Citizen Science. Participants in Citizen Science are trained as both citizens and scientists while at the same time they are encouraged to participate democratically in society and develop their scientific way of thinking.

More specifically, a key element of EE and of ESD is the shift from teaching to learning. Citizen Science involves a new type of engagement with science, which breaks the barriers of traditional science that is characterized by its distinct roles and and recognizes knowledge production only by professional scientists. This new engagement with science opens up new ways to learn, through a variety of experiences that are developed at a non-formal and informal learning level.

An important principle both in EE and in ESD is the idea of self-directed learning. Another core dimension of EE is that citizens participate in all activities entirely on a voluntary basis. They choose to take part driven by intrinsic motivations, whether these stem from an interest in science and research or from their reflection and desire to find solutions to the problems around them.

Also important, both in EE and in ESD is the concept of participation, which is of course a core element and key objective also of Citizen Science. More specifically, participation of lay citizens is promoted both in the scientific processes and in the discussion and decision-making on public issues. On the other hand, it also promotes the participation of scientific researchers in in relevant discussions and in decision-making as part of democratic processes.

A key feature characterizing both EE and ESD is that both approaches are clearly action-oriented and focused on real-world problems. Likewise, Citizen Science is based on and promotes the active involvement of citizens in various stages of scientific research, through democratic and collaborative processes supporting their action towards solving real-world problems around them (UNESCO, 2020).

Finally, both EE and ESD are not limited to formal education, but are considered lifelong learning processes (UNESCO, 2020), which can cross all levels of education and all contexts, formal, non-formal and informal learning. Similarly, Citizen Science, either as a non-formal type of learning, embedded in the school context, or as a purely informal form of learning, outside schools, exists as a piece of the palette of learning experiences that complement a seamless learning pathway.

Image 5: Citizens as agents of change in the face of the challenge and vision of sustainability.
Source: https://www.istockphoto.com/vector/crowd-of-people-composing-a-world-map-gm498891350-79911529

Summing up, it is important to note that the compatibility between the two fields does not eliminate their differences nor unique characteristics. Through their synergy each field can develop individually with a renewed perspective and dynamic. A perspective, through which Citizen Science will be perceived, for example, as a mechanism for empowering and transforming science and the community (Dillon, Stevenson & Wals, 2016). As Dunkley (2017) in particular points out, if we use EE/ESD as a prism through which to view Citizen Science,

then the role of Citizen Science transcends the one-dimensional scientific «understanding» of the world and takes on a social, political and emotional dimension. So the conjunction then of Citizen Science with EE/ESD and the interconnections that can be formed between the two fields has been seen as a major opportunity.

4.3. In what ways can Citizen Science be integrated into EE/ESD actions and projects?

Both EE and ESD have been proposed as educational processes and practices, which attempt to bring about changes: to the environment and society, to individuals and to education itself (Sauvé, 1994, 2002; Daskolia, 2005). All three of these interrelated perspectives are based on, and promoted through, a new pedagogy, whose rationale is not limited to merely revisiting the current curriculum and enriching it with sustainability concepts and issues, but instead extends to a holistic reform of the curricula and teaching methods by adopting interactive and student-centred teaching approaches, that are based on and promoting, inquiry-based learning and collaboration.

And it could not have been otherwise, since sustainability issues (such as climate change, biodiversity loss, food security, etc.), present multidimensional, and to a large extent, chaotic challenges, as they belong to the category of what are characterized as ''wicked issues", namely issues that are complex and unclear in nature and are consequently difficult to address (Gibson & Fox, 2013).

The great diversity and interdependence of environmental and social systems inevitably leads to the need to redefine the ways of looking at these issues since, for example, knowledge related to local issues may conflict with knowledge regarding similar issues in a wider context. Therefore, the traditional teaching approach is not suitable when addressing problems of this kind. A different way of thinking is required and, at the level of school learning, a redefinition of the educational process (Dillon, 2016).

On the other hand, Citizen Science is recognized as a new pathway for enhancing scientific knowledge and research skills (Bonney et al., 2009· National Research Council, 2009). It is an exploratory and empowering process, that aligns with the personal learning interests of adult citizens or their social concerns in relation to local or global issues (Crall et al., 2013· Wals et al., 2014· Jordan et al., 2016).

SIMPLE	Easy to solve. A clear problem with a clear solution. Predictable Straightforward Obvious
COMPLEX	Resists solving. The problem and the solution are not clear but can be understood with time. Many elements, although the elements themselves are familiar Hidden root causes Non-linear Inter-operating parts effect each other
WICKED	Resists defining Problem and solution not understood, and keep shifting when we try to define them Ambiguous, chaotic Many shareholders, with conflicting perspectives Many elements, many hidden and some hitherto unknown Strong social aspect Involves changes in belief, behaviour and/or identity No right/wrong solution Non-quantifiable No precedent

Text Box 4.2: Simple, Complex and Wicked Problems
Source: Gibson & Fox (2013)

Nevertheless, its connection with formal education has been little approached and exploited, despite the fact that school curricula offer many opportunities for students to actively take part in, and benefit from, Citizen Science projects and actions. The question is: in what ways can we best integrate Citizen Science into (formal) education, so that everyone involved can derive the maximum benefit from it.

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Image 6: Researching the world around us to solve real problem
Source: Cos4cloud

As seen in subsection 4.2, EE/ESD practice in schools provides a suitable and compatible framework for activating and forming creative synergies with Citizen Science. Learning experiences with reference to EE/ESD can be pedagogically designed to engage students (and other members of the school and local community) in activities and projects so that they can identify, explore and examine local environmental and sustainability issues. Investing in such actions the benefit is twofold: not only does it enrich educational practice, but the opportunities of ensuring a better environment and better quality of life for all are multiplied.

Approaches to Citizen Science based on the typology of Dillon, Stevenson & Wals (2016)

In the field defined as Citizen Science one can identify a diversity of projects that adopt and support different approaches. By looking closely at these approaches one can understand issues related both to the motivations that lead scientists and citizens to participate in these initiatives as well as the benefits derived from such partnerships. According to Dillon, Stevenson & Wals (2016) the different types of Citizen Science projects form a continuum, at one end of which one can discern more instrumental approaches to Citizen Science that are fully-led by scientists, whereas at the other end more emancipatory approaches in which citizens take the initiative.

• **Science-driven citizen science projects:** For these projects the agenda is fully set by the scientists. They assign the tasks (which often involve monitoring and data collection) and the citizen volunteers collect and share the data using prescribed protocols. It is the scientists who analyse the data and interpret the results and who present and publish them. Citizens can be informed about the results.

• **Policy-driven citizen science projects:** These Citizen Science projects seek to involve citizens based on the idea that public participation in science can support specific environmental protection policies and measures. Here too the scientists play a key-role in defining the issues at stake and determining what research needs to be done but there is also some flexibility regarding the ways in which citizens' ideas can be integrated and used.

• **Transition-driven citizen science projects:** This is a relatively new approach, that places even greater emphasis on the active "citizenship" of the participating citizens (civic science). It is the citizens themselves that have the initiative and responsibility to determine the questions to be addressed, collect the data and build new knowledge. It is a form of Citizen Science that is not driven, but rather supported, by motivations and people that are not linked purely with science or policy-making. Scientists, citizens and all the stakeholders participate in a joint learning process focussed on addressing complex sustainability issues.

Text Box 4.3: Different types of Citizen Science
Source: Dillon, Stevenson & Wals (2016)

According to the typology of Dillon, Stevenson & Wals (2016), the priorities of most Citizen Science projects and initiatives are either science-driven (starting from a scientific logic) or policy-driven (born from a necessity to document new or more appropriate polices). In comparison, there are far fewer Citizen Science

initiatives and projects aimed at bringing about real changes in the environment, society and people's daily lives (transition-driven). Nevertheless, the synergy between Citizen Science and EE/ESD can pave the way towards this, namely by promoting actions aimed at effectively improving the situation, through the transformation of the scientific research processes or through changes in the ways citizens engage with local sustainability issues. Therefore, by imbuing CT with the transformative perspective of EE/ESD, Citizen Science can move away from its instrumental character and evolve on the basis of a more emancipatory practice compared to its current state. A description of the various types of Citizen Science according to Dillon, Stevenson & Wals' typology (2016) is given in Text Box 4.3 (p. 92).

4.4. What are the learning benefits from integrating Citizen Science into school curricula

As discussed in chapter 1, Citizen Science promotes a new type of engagement for citizens in science and research. Its key characteristic is that it seeks to reposition science within, in relation to, and in interaction with society, by reinforcing its democratisation and supporting citizen participation in decision-making processes. It forms, therefore, an emerging 'paradigm' of scientific practice, which is based on, and promotes, collaboration between citizens and scientists.

On the other hand, integrating Citizen Science into the educational process offers many learning opportunities, turning Citizen Science into a similarly «emerging» paradigm of educational practice. In particular, Citizen Science that focusses on questions and issues of environmental management and protection can be explored in the context of EE/ESD, by providing a framework for, and enriching, environmental learning towards sustainability.

More specifically, integrating Citizen Science into the learning process is of great benefit to both schools and students. First of all, it increases the school's openness towards science since the pupils participate in collaborative research processes focussed on real problems in their local environment. Secondly, it acts as a mechanism for empowering the school community as a whole, not only by engaging it in scientific practices and developing new knowledge but also through its undertaking of initiatives and participation in dialogue on global and local environmental issues and sustainability issues. (Bonney et al, 2014).

Aspects of Citizen Science	What students learn from it	Related pedagogy
based on the scientific methodology	• *Working with research hypotheses and experimental design* • *Data collection* • *Drawing conclusions from observations and / or data* • *Critically thinking and discuss*	• *Evidence-based pedagogy* • *Inquiry-based learning* • *Theoretical knowledge*
in project design and management	• *How to manage a project and its resources (e.g. time, money, people)*	• *Project-based education*
community-based, involving various actors (individuals, agencies)	• *Interacting, connecting and collaborating with various stakeholders* • *Benefiting from the experience of others* • *Practising tolerance, patience and other key social skills from intergenerational learning*	• *Community-based learning*
centred on participation	• *Engaging into action* • *Getting motivated and developing self-confidence*	• *Action-oriented pedagogy* • *Hands-on learning*
dealing with «real world» situations	• *Apply theoretical knowledge to real-life situations* • *Focussing on concrete problems*	• *Authentic situation pedagogy* • *Learning-by-doing* • *Challenge-based education*
based on sharing culture	• *Practising openness and shared culture*	

Table 1: Aspects of citizen science
Source: DITOS consortium (2019, σελ. 2)

At a purely cognitive level, participating in Citizen Science projects that are related to the environment and environmental problems can foster students' scientific and environmental literacy. At the same time it also nurtures their ''ecological literacy'', i.e. the development of a new way of thinking and acting, which forms the basis for decision-making regarding major sustainability issues

concerning present-day societies at both global and local level (Jordan, Ballard & Phillips, 2012· Jordan et al, 2011).

In general, through Citizen Science projects, students are trained at several levels, both as scientists and as citizens developing knowledge, social and emotional skills, but also forms of action and behaviour that characterize a responsible and active citizen, as well as a "scientist" with social awareness and reflection. Voluntarily participating in solving real environmental issues strengthens their sense of solidarity and empathy, together with their curiosity and interest in science and life. All these characteristics give Citizen Science a unique potential that differentiates it from the standard projects of non-formal and informal learning in the school community (Jordan, Ballard & Phillips, 2012).

Related research suggests that students' engagement in Citizen Science projects can change their way of thinking about the concept of participation in community actions, thus strengthening active citizenship. Specifically, Ballard, Dixon & Harris (2017) who studied Citizen Science projects that involved young people and were implemented in parallel and complementary ways, both inside and outside the school, point out that when these projects were linked to specific processes within the community, such as a) rigorous data collection, b) the dissemination of results to a wider audience, and c) research into complex and multifaceted socio-ecological systems, then young people felt not only encouraged to participate in ongoing activities, but also to take part in current conservation actions but also in similar activities in the future.

Image 7: Looking more closely at already familiar environments
Source: Cos4Cloud

4.5. What are the conditions for an effective and meaningful integration of Citizen Science into school curricula?

Following on from what has been discussed so far, it is argued that Citizen Science can function as a trigger also for for revisiting and transforming the way in which learning is promoted through the school curricula. This prompts us to

think about educational practice itself and the school curricula in new ways.

International experience from Citizen Science projects connected to school education shows lacking duration and replicability, one-off events with no follow-up (DITOS consortium, 2019). Research however has shown that fragmentary actions, that have no duration and iterability, do not help students to achieve meaningful social and scientific goals (DITOS consortium, 2019). Therefore, integrating Citizen Science in the context of EE/ESD is important to be done in a systematic way, as this multiplies the chances of highlighting deeper and more meaningful learning objectives and of achieving changes towards sustainability.

Liu & Kobernus (2017) argue that particular attention should be given to the fact that Citizen Science projects should be designed in a way that is "participant-led", i.e. linked to both the interests and skills of students. This fosters enthusiasm and enjoyment, which are two of the main drivers and are important factors in the success of Citizen Science projects.

> *"... the strength of citizen science programs directly relies on the curiosity and pleasure of the volunteers to learn and observe things that they have never noticed in their most familiar places."*
>
> (Liu & Kobernus, 2017, page. 163)

Another point worthy of attention is, according to Jenkins (2011), that the integration of Citizen Science into educational practice should seek to build connections between students' everyday lives and science. This is particularly important since the research indicates that students' experiences of science are to a great extent negative, also due to the fact that science, as taught in schools, is not connected to their daily lives. Citizen Science lends itself to the development of a "bridge of communication" between science and education and the cultivation of a scientific literacy through the democratization of science (Gray, Nicosia & Jordan, 2012).

Moreover, by introducing science into the classroom and engaging students and teachers in Citizen Science practices, epistemology and scientific research methods become open and accessible and the nature of science itself is discussed in connection with the curriculum. This of course means that scientists, on their part, must relinquish full control over the scientific research and offer their tools for use in the classroom (Gray, Nicosia & Jordan, 2012). It also means that teachers must broaden their perspectives, making room for new, perhaps less certain, but at the same time more "innovative" practices, breaking away from the more usual and established reasoning of science experiments (Grandy & Duschl, 2008). Lastly, teachers need to ''communicate" science to their students instead of merely transferring already acquired knowledge (Shah & Martinez,

2016). This means that both they themselves and the wider school community should be ready to accept open and unstructured student-centred practices.

Ultimately, a holistic approach to these practices must involve also the engagement of the school and the community. Interactive and student-centred processes, through which different forms of learning are developed, are best promoted in the context of whole-school approaches as in the case of "ecological" schools or "eco-schools", and even more so of "sustainable" schools (Dillon, 2016).

Rounding up, to ensure the quality and effectiveness of the processes when integrating Citizen Science into school curricula through EE/ESD the following criteria should be taken into account and an attempt should be made to adhere to them (DITOS consortium, 2019, page. 4):

- Allowing time for conducting Citizen Science projects in schools
- Training of teachers in the design and implementation of such projects
- Moving away from ''right-wrong'' types of assessment
- Developing assessment tools for skills and fostering curiosity and reflection
- Supporting local stakeholders to develop pedagogical content and programmes in collaboration with teachers
- Encouraging partnerships between the local and the school community.

4.6. What are the benefits for Citizen Science from its integration into school curricula?

In a previous subsection we discussed the learning benefits of integrating Citizen Science into school practice using the EE/ESD as a vehicle. Extending the discussion, here we consider whether the this partnership between Citizen Science and EE/ESD works for the benefit of Citizen Science itself, by evolving it both as a field and as a and as a practice.

According to the study by Hecker et al (2018), Citizen Science projects and initiatives have been predominantly pursued within the realms of the natural sciences, while initiatives linked to the social sciences and humanities are noticeably fewer in number (Heiss & Matthes, 2017). Likewise, the predominant orientation of most Citizen Science projects to date appears to be ''scientific only''.

The first element that has a renewing effect and also to the benefit of Citizen Science, is that through its partnership with EE/ESD efforts are strengthened to reexamine this orientation and to open up Citizen Science towards an interdisciplinary focus and methodology, that is not limited only to the perspective and tradition of the natural sciences but also extends to the

social sciences and humanities. This dimension emerges as a prerequisite for a multifaceted and comprehensive approach to environmental issues, with the contribution of diverse disciplines (Tauginienė et al., 2020).

A second element relates to the audience to which Citizen Science has traditionally been addressed so far and the context of the learning processes it promotes. Adults are the main target group of most Citizen Science projects where the activities take place mainly in non-formal and informal learning environments. There are comparatively far fewer cases of Citizen Science being implemented in school education. In this sense, integrating and promoting Citizen Science through EE/ESD actions in schools and in other types of formal education broadens the scope of Citizen Science to a new and dynamic audience. The pursuit of common goals is thus strengthened across the length and breadth of education, as part of a lifelong learning process. In addition, it addresses a special, uniquely important audience, which through engagement in education can develop the appropriate knowledge, values and skills, thus constituting an important investment for the future.

4.7. Are there examples of Citizen Science projects implemented in schools?

As already mentioned, in recent years the importance of Citizen Science as a mechanism for empowering the school community, with significant learning benefits both for the students themselves and for the school community as a whole, has begun to be recognised (Bonney et al, 2014). Consequently a large number of Citizen Science projects have already made their way into schools involving students of all ages and levels, from preschool to university. Some Citizen Science projects have been included in the school curriculum and students participate in them in a "formal" way, while in others, especially at higher levels, students participate by their own choice (Dunkley, 2016). Projects implemented in schools vary as regards the degree and method of their involvement with research, with many of them contributing data to scientific studies (Dunkley, 2016).

Some examples of Citizen Science projects implemented in schools are given below:

Seeds in Space

The project is based in the United Kingdom and involves an observational activity that looks at whether and how seeds grow in space compared to school

grounds. Astronaut Tim Peak launched this project with a view to combining it with his space mission. It is a collaborative project between the Royal Horticulture Society, the UK Space Agency and a large number of schools in the United Kingdom (Dunkley, 2016).

ENVIRAD-Radiolab project

This project was initiated by the Radioactivity Laboratory of the Physics Department at the University of Naples, which worked with secondary school students to carry out measurements of radiation emissions, focussing on the risks associated with radioactivity. More specifically, the project was conducted through a survey of 49 schools and 1000 students. Students were responsible for data collection and were directly involved in radio emission measurements carried out over a long period of time. In some cases they were also responsible for measurements performed in sites other than the schools, in order toraise awareness of this issue among other citizens. The main aim of the project was to generate scientific evidence that would be directly usable by the scientific community and useful for the students themselves. Through this, the connection between science and society was promoted and students were made aware of the multiple connections and interactions of science on an issue (Ellenburg et al 2019).

GLOBE Program

In 1994 the American government announced the launch of the Global Learning and Observations to Benefit the Environment (GLOBE) Program, as an effort by various organisations to involve students and citizens from around the world in collecting data about the environment and the Earth as an ecosystem. In this project, students and citizens collect data on the environment following the guidelines of a set of well-designed protocols and they upload them on a digital platform (Balzano, Miele & Serpico, 2016).

Future Forest

In this project Citizen Science was used as an educational tool in the context of formal education. Participating students were involved in a DNA barcoding project. By using DNA barcoding students can perform genetic identification of species. 276 high school students from Germany took part in this project in the context of an education module on biodiversity (Schneiderhan-Opel & Bogner 2020).

Examples of Citizen Science projects appropriate for school-age students		
Education level	**Title**	**Description**
Elementary school	Journey North www.learner.org/jnorth/	Students investigate global wildlife migration and seasonal change.
	FeederWatch www.birds.cornell.edu/pfw/	Students set up bird feeders and observe when the birds are feeding. Data collection is on the type and number of birds.
	Bee Hunt www.discoverlife.org/bee/index.html	Students make a list of pollinators in a given place using photographs to identify insects and plants.
Middle school	Encyclopedia of Life www.eol.org/	Students take wildlife photos, annotate, research and write about the species on Earth.
	Galaxy Zoo www.galaxyzoo.org/	Students examine images of space and classify them according to their shape, allowing scientists to understand galaxy formation while students gain experience to astronomy research.
	S'Cool http://scool.larc.nasa.gov/	Students observe clouds at particular times focusing on type, height, coverage rate and thickness.
	World Water Monitoring Day www.worldwatermonitoringday.org/	Students use test kits to monitor the health of local water resources by measuring pH, dissolved oxygen, temperature and turbidity.
High school	FoldIt http://fold.it/portal/	Students become familiar with synthesis and breakdown of proteins including how structure affects function.
	Nature's Notebook, USA Phenology Network www.usanpn.org/home	Students observe and identify specific plants and animals in a region to determine the effects of global climate change on vegetation and wildlife.

Table 4.2: Examples of citizen-science projects appropriate for school-age students
Source: Shah & Martinez (2016)

Shah & Martinez (2016) also document a number of examples of citizen science projects that are appropriate and implemented or can be integrated into school practice by grade level (see Table 4.2).

Image 8: Seed development in the 'Seeds in Space' projec
Source: https://www.esa.int/Science_Exploration/Human_and_Robotic_Exploration/mISSion_possible/PROJECT_Seeds_in_Space

To sum up…

Citizen Science converges with EE/EES, since they both seek to cultivate the idea of the active and responsible citizen and place it at the centre of their practice. There are many points connecting the two fields and several common principles and approaches that make Citizen Science and EE/ESD compatible and complementary to each other. These include the central role of learning, key concepts such as participation and active citizenship, orientation towards action and real-world problems. Integrating Citizen Science into school curricula is challenging, however EE/ESD appears to be a suitable and compatible framework for activating and forming creative synergies with Citizen Science. Integrating Citizen Science into formal education generates many benefits, both at the learning level and at the general level of educational practice, making Citizen Science an emerging "paradigm" of educational practice. However, in order for its integration to be effective and meaningful, a series of 'conditions' must be taken into account that will help ensure that the benefit is mutual. Although the prospects for creative collaborations in this direction are still open, specific cases from international projects already indicate considerable interest and an active presence.

Research: Participation of schools in Citizen Science research

Based on their research conducted with secondary school teachers and students as part of a Citizen Science project entitled, 'Helsinki Urban Rat Project' (HURP; https://www.helsinki.fi/en/projects/urban-rats), Aivelo & Huovelin (2020) drew the following conclusions in relation to the implementation of Citizen Science projects in schools:

"Our study highlights some critical points that need to be considered for participation in citizen science projects to be successful. Firstly, the aims of teachers and students need to be aligned with the researchers who are running the project. In an optimal case, the citizen science project can fit perfectly to a curriculum and provide a ready-made package for teachers to use. Secondly, teachers cannot be passive participants in the project, but they need to react to the experiences and outcomes of student participation. We suggest that there is a need for discussion in the classroom on the objectives, problems related to, and eventually experiences during the citizen science project. While some students might acquire meaningful learning experiences just by participating, a chance to reflect on the project in a classroom would provide many more opportunities for learning. Thirdly, analysis of the data would provide further opportunities for learning; a collaborative or co-created citizen science project could be even more valuable from an educational point-of-view. Nevertheless, there is a trade-off on how much course time teachers can dedicate to a citizen science project and how deeply students can become involved (Silva et al. 2016). We suggest that our approach can enable teachers to participate because it does not take much time, but this comes with a possible trade-off for more shallow learning experiences."

(Aivelo & Huovelin, 2020, p. 336)

Case study: "The secret Life of city"

Two national education projects based on the Pl@ntNet platform

The aim of the case study presented here was to highlight a new form of EE and ESD projects based on participatory science and artificial intelligence technologies using the Pl@ntNet Citizen Observatory platform. The project was implemented in two central European countries: Slovakia and the Czech Republic.

The project

The project was carried out in two non-governmental, non - profit organizations:

- Zivica, Slovakia (http://www.zivica.sk) και
- Tereza, Τσεχία (http://www.terezanet.cz//cz)

In both countries, botany at school is taught mainly inside the classroom or in the schoolyard. To promote learning about botany through more direct interaction with nature, the abovementioned organisations sought a new approach based on direct student-nature contact. The project focused on important plant species that can be observed within or close to cities, to emphasize the fact that plant biodiversity exists and is important both in cities and in remote natural areas.

In the methodology followed students and teachers became researchers, combining their efforts to inform the wider community about the diversity of plants in their city, town or village. There was a range of activities, of varying degrees of complexity, so as to spark the creativity of the students.

Aim: The main aim of the project was to raise public awareness of the surrounding environment and to emphasize the importance of biodiversity in cities as an important element of sustainability.

Duration: The project's duration was two years to give the participants ample time to develop new skills.

Description

Both organisations invited 350 schools in each country and at the same time made use of the European network of "Eco-schools" network ('Eco-schools', http://www.eco-ecole.org). Participants were primary and secondary schools attended by students aged 9 to 15.

The call included:

A) A project description (goals, expected benefits for the students and student, teacher and school commitments)

B) Description of teacher and student training courses

C) Description of the equipment schools would receive (4 tablets per school per year and a one- or two-year commitment request).

50 schools were selected from each country. The total of schools was 100, operating in large cities (e.g. Bratislava, 432,000 inhabitants) and towns (e.g. Vojcice, 2,200 inhabitants).

Teacher training

The project included a training project for 50 teachers in each country. Training was conducted through 3-day seminars attended by groups of 25 teachers. Various methods of facilitation were used during the training program. The goals were for the teachers to experiment with the use of Pl@ntNet and to enhance their knowledge of urban biodiversity and its protection.

The University of Zvolen also took part in the training project, communicating to the teachers its knowledge and experience in biodiversity and ensuring correct use of the Pl@ntNet platform.

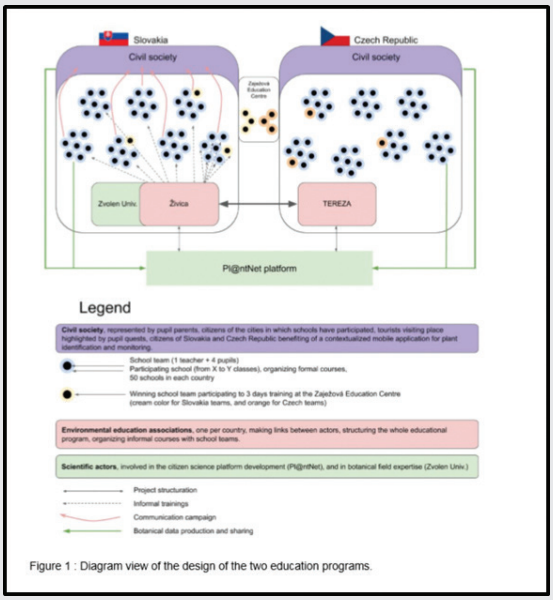

Figure 1: The implementation design in form of a diagram.

Preparation of the schools

A team was formed in each school comprising one core teacher (who had been trained) and 4 selected students. A training seminar was organised for these teams in each country. 7 teams participated in each seminar. The teams were divided according to geographical location.

The aim was to promote the discovery of urban biodiversity. The students were introduced to the Pl@ntNet platform so that they could collect observations from 5 plant species and identify the plants with the aid of the Pl@ntNet image recognition algorithm.

The students had access to 4 tablets and books to help them confirm their observations. At the end of the project every team presented their observations to all participants in the form of a poster. This would also train them in communication and prepare them for the next step of the project. Through this training, the students:

a) discovered part of the urban flora

b) learnt to use the application

c) learnt to collaborate

d) were trained in methods of recording and communicating knowledge.

Transfer of knowledge within schools

The role of the trained students was twofold: On the one hand they would make the Pl@ntNet application known to the other students and on the other they would help to record a large number of correctly identified plant observations via Pl@ntNet. The Pl@ntNet app is free and available online for iPhones or Android, so it could be easily used by all students.

The target set for each school was, as an initial step, to record and share 50 observations in the first month. The observations should: a) not to be too easy to make, b) capture as many species as possible that did not have a strong presence on Pl@ntNet and c) present, if possible, rare and endemic plant species. Every school had a user account on Pl@ntNet so it was easy to track all observations made.

Communicating the project to the general public

In addition to dissemination within the school itself, the school teams conducted public information campaigns. Each school's campaign differed according to the desired format and means available, and included:

- leaflets
- stands with games based on the observations
- actions with the general public
- journal articles
- radio broadcasts
- press releases
- T-shirt creation

The information campaigns were very often supported by local tourist operators/providers with a view to informing also the tourists and getting them to participate in the actions.

Rewards and incentives for teams:

The 3 best teams from each country that had most successfully promoted the biodiversity of their city/town/village were rewarded with a 3-day educational visit to Zajezova Education Centre (http://www.centrumzajezova.sk/), to benefit from another interesting learning experience.

Strategy for continuing the project in the 2nd year

For the transition from the 1st to the 2nd year there was an evaluation stage. At the end of the 1st year, in order to remain in the project, the schools had to submit a report. In the report they recorded their best observations, as well as the method used for communicating with the public. The quality of the report was the criterion for the evaluation of the schools and also for continuing their participation in the project. Otherwise new groups would be selected based on the same criteria and in the same way as at the start of the project.

The second year followed the same logic as the first but with the addition of one more goal: an adventure/exploration to discover important monuments in the city. The exploration was based on a questionnaire that allowed students to perform a search in their city/town/village in order to discover its natural, historical and cultural heritage. The questionnaires for the exploration were structured in such a way that the participants had to reply to one question before being able to proceed to the next. These explorations took the form of a story inviting the participants to "travel" and learn about their environment. The questions also included plant identification using Pl@ntNet.

At the end, participants arrived at some point of their city where a ''treasure" had been placed. Some routes had been designed to be followed on foot and others by bicycle.

These explorations were not only for students but for the general public too. They were also promoted by local tourist offices through posters or local websites.

Results

All those involved had significant benefits and gained from their participation in the project:

• The research organisations had a greater geographical coverage of the European flora

• The NGOs acquired a free, simple and useful tool for the observation, identification and recording of local flora

• The teachers, schools and students themselves gained access to and learned about a new use of materials, tools and methods, as well as being trained in new activities

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PART TWO

From theory to praxis: proposed educational scenarios

CHAPTER 5

SIX EDUCATIONAL SCENARIOS
FOR THE INTEGRATION OF CITIZEN SCIENCE INTO SCHOOL-BASED PROJECTS AND ACTIVITIES OF ENVIRONMENTAL EDUCATION / EDUCATION FOR SUSTAINABLE DEVELOPMENT

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5.1 The context for developing the six educational scenarios

The Environmental Education Lab of NKUA (EEL-NKUA) has been an official partner of the European project Cos4Cloud. As part of its role in the project, to study the potential for bridging citizen science and EE/ESD and to help promote citizen science in school-based EE/ESD with mutual benefit for both, the EEL-NKUA organised and implemented a six-month online teacher training course (July - December 2020). Its main objective was to empower participants - EE/ESD teachers and stakeholders -through raising their awareness and developing their reflection on fundamental concepts, ideas, tools and practic-

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es of citizen science and its intersection with EE/ESD, as well as by drawing ontheir knowledge and experience. In particular, in the fifth and final cycle of this training program, participants were invited to reflect, exchange ideas and develop together, in an organised and analytic way, their own proposals on "how citizen science could be integrated into school practice through EE/ESD". Six educational scenarios were co-created in the context of this training cycle by different groups of participants, with the support, coordination and feedback of the NKUA team (Daskolia, Piera & Soacha, 2022). In this chapter we first introduce and describe the concept of "educational scenario", then we present the scope and process of the co-creation task and finally we discuss the main characteristics of the scenarios created and other aspects they have in common. In the chapters that follow, we present each of the six scenarios in greater detail.

5.2 Introducing the concept of educational scenario

A relatively general use of the term "educational scenario" revolves around the idea of a written document that describes as precisely as possible an educational action or intervention that is (or could be) designed to be implemented in a specific educational population and within a predefined educational context to meet identified learning needs and objectives[1]. Thus, an educational scenario can be either a description of an educational intervention, or a proposed plan on how to implement it, in which a clear and detailed reference is made to its various pedagogical dimensions: how it is deployed, the principles and assumptions on which it is based, the anticipated learning activities, as well as the resources, tools and measures required for its successful implementation.

Those involved in developing an educational scenario are invited to identify and explain about issues regarding the topic and subject matter of the educational action and the way it will be didactically approached, as well as to reflect on the added value of the learning tools (digital and other) proposed to be used, as well as on the nature of the innovation. Thus, an educational scenario serves as a plan for organising and describing the teacher's instructional, scientific, and methodological choices in relation to a learning situation or challenge; at the same time, it provides a frame of reference, guidance, and evaluation of the teaching practice for the teachers involved. In this sense, an educational scenario can (and should) function as a "boundary object" (Daskolia, 2015), by facilitating communication, exchange

[1] See Kynigos, Daskolia, & Smyrnaiou (2013) for more on the concept and use of the "educational scenario" as an approach and tool for instructional design, especially in the context of teacher training.

and collaboration between teachers and other actors of the educational practice, as well as inspiring and enabling the creative production of new educational scenarios and learning tools. Through all these uses, to create an "educational scenario" is not only a process or a tool for instructional design but also a central modality of teachers' professional practice and adds to the teachers' professional development as "designers of learning experiences" (Kynigos & Daskolia, 2021; Kynigos, Daskolia & Smyrnaiou, 2013).

5.3 The co-design process of the six educational scenarios

In the context of the Cos4Cloud's online teacher training course, the idea was that "educational scenarios" would be used as an invitation and a tool for the participating teachers to collaboratively design and describe innovative educational actions for the integration of citizen science into EE/ESD. They would also function as means of fostering reflection and facilitating discussion on their choices regarding scientific content, pedagogy, and the use of Citizen Observatories (COs) technologies and apps in EE/ESD processes (Daskolia, Piera & Soacha, 2022).

To this end, the NKUA researchers designed "a template" of an educational scenario, with a well-elaborated structure and several fields open for completion by the teachers, accompanied by a set of clarifications and instructions on how to fill them in. The selection and configuration of these specific fields aimed at addressing a range of pedagogical and teaching considerations on the part of the teachers. The teachers worked in groups of 3 to 4 to elicit, share and edit their ideas, discuss their different choices and transcribe their suggestions into written documents, with the scenario template as a descriptive framework.

Upon completion of the co-design process, each group presented their scenario and received feedback from both the NKUA researchers/teachers and the other participants. The documents of the educational scenarios were then subjected to thematic analysis by the EEL-NKUA researchers to identify the ideas they contained and the choices they expressed (Daskolia & Grillia, 2016; Grillia & Daskolia, 2019). Three of the participants of the training course and designers of educational scenarios (the 2nd, 3rd and 4th author of this chapter) were invited to take part in the analysis and discussion, to enrich these processes with their perspective a "educational designers".

In the following sections, the six scenarios are briefly presented and then their main features and other aspects of interest in terms of their identity and suggestions are briefly highlighted and commented on.

5.4 Overview of the six educational scenarios

Educational scenario 1 (S1) introduces students of the last grades of primary school to citizen science through the Pl@ntNet app, with the aim to investigate the biodiversity of a suburban forest in Attica (that on Mount Hymettus) and their school garden. The project evolves through more than one stage and educational activities, to support students to develop new knowledge about plants (endemic and invasive) and to reflect on the factors affecting floral diversity (such as climate change, fires, deforestation, encroachment, etc.). Students are also helped to create a botanical guide and a botanical trail, as well as to meet members of the scientific community in person. All activities are suggested as different ways to enhance the students' environmental and scientific literacies.

The theme of **educational scenario 2** (S2) is odour pollution in the school and the surrounding neighbourhoods. This scenario takes an interdisciplinary approach linking citizen science with EE/ESD through the OdourCollect app. It comprises several play-based activities and sensory experimentations. Primary school students participate in sensory walks, keep odour diaries, create thematic maps, and consider the impact of unpleasant odours on socio-economic life and public health, social interactions and students' perception of their school environment. After participating in a project based on this scenario, students are expected to become agents of change for a more sustainable future in their school and local community.

Educational scenario 3 (S3) aims to integrate citizen science in EE/ESD through the pedagogical use of Pl@ntNet and OdourCollect apps on a particular site, the former industrial site of the Fertilizer and Chemical Plant of Drapetsona (near Piraeus city and the Saronic Gulf). Following an interdisciplinary approach, students of the last grades of primary school are supported to create thematic maps, digital posters and postcards and to formulate their own plan for the sustainable regeneration of this former industrial site. The scientific paradigm of observations and measurements with Pl@ntNet for plant identification is complemented by the use of OdourCollect for recording odours and air pollution incidents. It is also combined with the collection of local history narratives and social data on popular culture, through which issues of values and rights are highlighted. It is suggested that an adapted version of the scenario could also be implemented in the context of a cross-curricular project on school gardens or an intercultural education project.

In **educational scenario 4** (S4), the link between citizen science and EE/ESD is achieved through an interdisciplinary approach and the use of the Pl@ntNet and Natusfera platforms. The scenario encourages collaboration between high school students, teachers, out-of-school institutions and members of the academic community. It addresses several objectives and activities, such as the improvement of the school garden as a learning environment, awareness raising on climate change as a biodiversity issue and individual and social responsibility for tackling it, the creation of a beneficial microclimate in the school environment, the construction of a plant fence to absorb noise and chemical pollution, the launching of composting activities in the school and initiatives to raise awareness in the school and the local community, etc.

Educational scenario 5 (S5) builds on the environmental theme of urban streams, which it defines as "islands of biodiversity" in the urban environment. It also focuses on the identification and study of invasive plant species in urban streams and the risks of induced changes in their ecosystems. It is addressed to high school students, who assume the role of young researchers, identifying and photographing the main plant species in their local stream (the Halandri Creek), then recognizing them through the Pl@ntNet app and finally carrying out a literature review and a virtual tour of the area. Apart from emphasizing the value of urban streams, the scenario seeks to integrate citizen science into EE/ESD by promoting practices and skills that contribute to the collection of different types of scientific data and advance environmental science inquiry. The implementation of the project is complemented with a visit to an Environmental Education Centre that implements a relevant educational program on streams (the EEC of Argyroupolis: "The stream of Pikrodafni").

Finally, **educational scenario 6** (S6) aims to link citizen science with EE/ESD and Oral History (OH), using the OdourCollect platform of the International Citizen Observatory on Odours. Through an interdisciplinary approach, secondary school students work with teachers, the local community and other stakeholders to highlight the problem of olfactory pollution in modern cities through the pedagogical use of oral narratives collected from residents. In addition, students create a digital sensory map of local odours, which they enrich with the stories of local residents, cultivate their olfactory sense of their local area and engage in active citizenship activities.

5.5 A comparative analysis of the six educational scenarios

The first three scenarios (S1, S2 and S3) - in the order presented in the following chapters - were designed to address primary school students (mainly the last two grades of primary school), while the other three (S4, S5 and S6) secondary

school students. Each of the scenarios involves the carrying out of educational activities and inquiry-based learning in six distinct places of different scales and contexts respectively, all in urban environments (such as the school garden, the neighbourhood, the city, urban streams, the suburban forest, or a former industrial site), and by bringing students up close to real environmental problems in their local area (such as biodiversity decline/alteration, climate change, air pollution, etc.).

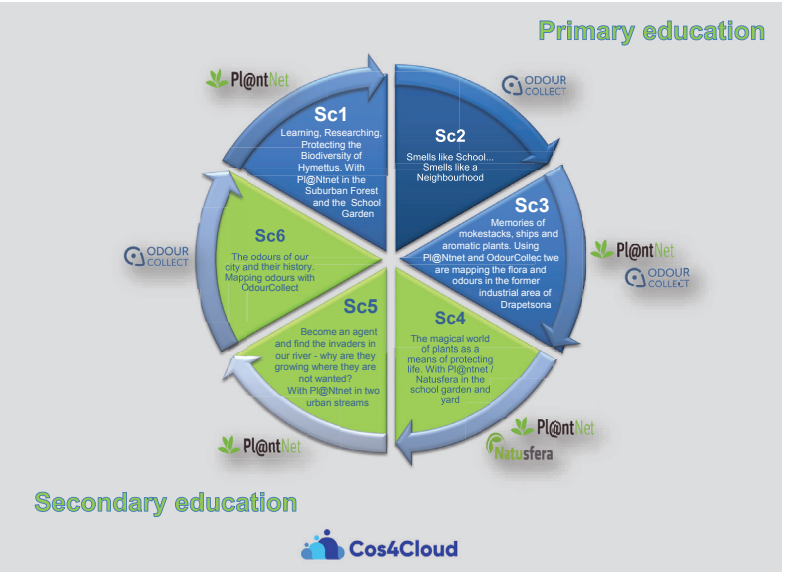

Image 1: A schematic representation of the 6 scenarios

All six scenarios aim to promote both environmental and scientifi c literacy among students and include a range of educational activities to familiarise them with citizen science. Most of these activities aspire to go beyond an instrumental approach to citizen science. Besides science-driven citizen science approaches, they aim to foster active citizenship through the involvement of students in decision-making and policy-making (policy-driven citizen science), while some aim to promote change from a transformational perspective (transition-driven citizen science). Regarding the use of the CO technologies and tools, in four of the scenarios fi eld work and the recording of data is done with the use of Pl@ ntNet app (S1, S3, S4, S5) or combined with Natusfera (S4) and address mainly plant species. In three of the scenario the tool used is OdourCollect app (S2, S3, S6) to address odour pollution or smells and odours in the environment.

Each of the six educational scenarios has a distinct thematic focus, refers to a different context and focuses on specific environmental problems. Similarly,

it sets concrete educational goals linked to the issues addressed and uses more than one pedagogical approach to achieve them. Thus, while each scenario retains its uniqueness, authenticity and originality, all six offer a plurality of approaches.

Among the key features shared by all educational scenarios are the following:

1. They build on creative, pedagogically sound and feasible activities, which are grounded in a range of comprehensive and interdisciplinary educational approaches.
2. They promote active and experiential learning and seek to develop critical thinking, action competence and scientific and environmental literacies.
3. They emphasize the pedagogical use of digital tools for learning that foster both analytical and creative thinking.
4. They seek to open up learning to the whole school and local community and to engage and connect students with their local area.

5.6 Proposed ways of integrating citizen science into EE/ESD

Regarding the integration of citizen science in EE/ESD, the strategies chosen to be used, as reflected in the educational scenarios, are carried out at four different levels, which are presented below with reference to indicative activities[2]:

(a) Students are introduced to citizen science, and develop knowledge on fundamental concepts and ideas about citizen science, the COs and the platforms and apps they use, and become familiar with their use, studying how to enter data through their apps [see S1, A2.3 (PL@ntNet) - S5, A1.6 (PL@ntNet) - S6, A1.3 (OdourCollect)].

(b) Students make observations, record them and enter them on the CO platforms. This is done in different places (in the school unit, in the neighbourhood, in a park/grove, in a suburban forest area, in a former industrial area, in urban streams, etc.). At the same time, they combine the collection of data related to flora species or different odours with other observations, such as visible or less visible "signs" of climate change with impacts on biodiversity, changes in flowering/fruiting periods, identification of odour pollution hotspots with unpleasant

[2] The reference is as follows: Sx ("Scenario number", e.g. S1, meaning "Scenario 1"), Ay.z (Activity number in relation to phase (y) and number (z) as described in the scenario, e.g. A2.3, meaning Activity described in Phase 2 and numbered 3rd in the sequence). The name of the CO used as platform or app is given in brackets (e.g., Pl@ntNet).

effects on school life and/or the local environment of students' daily lives, etc. Activities of this kind often bring up a multitude of memories and emotions, which involve students even more powerfully in the educational process. [see S1, A2.3 & A3.2 (PL@ntNet) - S2, A1.4, A2.1 & A2.2 (OdourCollect) - S3, A1 (Pl@ntNet & OdourCollect) - S6, A2.2 (OdourCollect)].

(c) Students practise and develop scientific skills by acting as natural and social scientists. This is done through their participation in the design and implementation of field research, the collection of additional information and accounts through interviews (asking old people) and questionnaires (learning from younger people), reviewing relevant literature, comparing cases, analysing data and writing reports. [see S2, A2.4 (OdourCollect) - S3, A1.1, A1.2 & A1.3 (PL@ntNet, OdourCollect) - S4, A2.1 & A2.2 (Pl@ntNet/Natusfera) - S5, 1.4 & A2,A3 (PL@ntNet) - S6, A3.2 (OdourCollect)].

(d) Students are empowered by acting as active citizens and agents of change in the local community, highlighting real problems and seeking solutions. Such actions include creating biodiversity trails in their schools, meeting with local officials, developing proposals for the regeneration of their local environment, participating in new plantings, combining different kinds of findings, and undertaking actions to inform the local community. [see S1, A4.1 (PL@ntNet) - S2, A3.3 (OdourCollect) - S3, A2.3 & A2.4 (Pl@ntNet, OdourCollect) - S4, A3.1, A3.2 & A4.1 (Pl@ntNet/Natusfera) - S6, A2.3 & A4.3 (OdourCollect)].

5.7 Afterword

Since the spring of 2021 until today (2023), all six educational scenarios have been implemented more than once, mostly in schools in Attica but also in other Greek regions, by the teachers who originally designed them, as well as by other teachers who became aware of them in the training workshops and seminars organized and conducted by the EEL-NKUA team. Some scenarios were tested in regular school conditions or adapted as appropriate (i.e., for the distance learning format of the school during the Covid-19 pandemic). Some were redesigned by their creators, enriched or extended to meet new educational needs, in order to respond to different student profiles or interests, or as a follow-up to their first implementation in schools (Daskolia, Pappa, Joly, Bonnet, Arias, Piera, Soacha, 2022; Daskolia, Trigatzi, Piera, Woods, Bonnet, 2022).

It is also important to note that almost all the educational scenarios served as a source of inspiration and reference for the development of new scenarios, by the same teachers or by other teachers, with similar or different thematic focus, with a shorter or longer planned duration, with greater or lesser adaptation (Daskalaki, Daskolia & Gkotzos, 2022). They thus fully fulfilled the role for which they were created, to empower teachers to act as "designers" of educational innovations, and to experiment, reflect and communicate their knowledge and practice.

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SCENARIO 1

I STUDY, EXPLORE AND PROTECT THE BIODIVERSITY OF HYMETTUS.
IN THE SUBURBAN FOREST AND IN THE SCHOOL GARDEN WITH PL@NTNET

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Age range:	5th & 6th grade of primary school / possibility of implementation for younger students with developed digital skills, students with learning difficulties or disabled students (need for a level outdoor space)
Duration:	approx. 3 months (20 teaching hours)
Tool/Platform:	Pl@ntNet
Scope:	At the foothills of the suburban forest of Hymettus
Keywords:	biodiversity, plant diversity, forest ecosystem, environmental/ botanical trail, climate change, observation grid, botanical guide, endemic/ invasive plants, environmental awareness, active citizenship

Citation: © Vorylla, V., Drossou, A. & Michaelidou, I. (2023). I study, explore and protect the biodiversity of Hymettus. In the suburban forest and in the school garden with Pl@ntNet. In M. Daskolia (Ed.) *Environmental Education for Sustainability and Citizen Science. Integrating environmental citizen observatories into school educational practice* (pp. 123-136). National & Kapodistrian University of Athens Press. https://doi.org/10.26247/nkuapress.ebook.2

BRIEF DESCRIPTION

The scenario approaches the issue of biodiversity and chooses to focus on the study of forest ecosystems and specifically on the study of plant diversity. The aim is to introduce students to research processes, as it links education with research. Participants will acquire knowledge about plants (rare endemic and invasive plants) and their classification, will reflect on the factors affecting plant diversity (climate change, fires, deforestation, illegal trespassing) and are expected to enhance their environmental awareness. The research nature of the scenario will enable the students to carry out their own research, as they will collect data and photographic material from the school environment and the nearby suburban forest (Hymettus), use observation grids, and learn ways of managing the collected material. By making the best use of the Pl@ntNet app, they will gain hands-on experience of active citizenship, as they will have the opportunity to identify plants and be inspired to create their own botanical guide and botanical trail. It is also suggested to get in contact with an expert (biologist) in the context of a constructive discussion about biodiversity in Hymettus.

CONNECTION WITH CURRICULUM SUBJECTS

Geography:	the flora of Greece (biodiversity - the extinction of species), ecosystems of Greece, vegetation zones, weather and climate of a region
Visual arts:	application of the technique of "leaf printing"
ICT:	new technologies and digital devices (use of tablets, mobile phones, cameras), creation of data tables (categorisation of plants in tables based on their name, characteristics, etc.), creation of a digital puzzle
Language:	parts of speech (recording nouns, adjectives, verbs in relation to the images presented in the video), lifestyles and professions (interview with an expert scientist biologist/forester), direct and indirect speech (during the interview)
Natural sciences:	parts of the plant, photosynthesis, plant respiration/breathing

LITERACIES

Environmental literacy

- reflecting on the value of biodiversity with a view to protecting it
- becoming aware of the diversity of species
- practising the detailed observation of plants
- becoming aware of the relationship between climate and plant species in a region
- contact with nature
- dealing with plant diversity and approaching it by
- observing and recording data in the field

Scientific literacy

- becoming aware of the two-way relationship between education and scientific research
- using new technologies and their connection with scientific research
- developing observation skills, pattern recognition, categorisation
- becoming aware of the processes of studying the natural environment
- contact with the profession of biologist (interview with an expert)
- using scientific procedures to record, collect, and categorise data with observation keys and digital applications, such as Pl@ntNet

Citizenship literacy

- developing environmental awareness of their school and the surrounding area
- becoming aware of the value of collective action
- taking action to inform the wider community
- informing and raising awareness among students and the community

Digital literacy

- familiarisation with taking digital photographs and managing their files (transferring files from digital camera to PC)

- contact with the concept of artificial intelligence (photo recognition and use)
- creating digital puzzles and sharing them

Basic literacy

- developing vocabulary to describe biodiversity
- mastering the technique of leaf printing
- becoming familiar with the concept of the square metre

GOALS / SKILLS

Creative thinking:	assigning fictitious names to plants
Critical thinking:	plant identification with observation grid & digital application
Communication of ideas and information:	creation of a trail
Collaboration - teamwork:	team activities
Developing initiatives:	ideas for creating an environmental trail
Project production and consistency in execution:	building an environmental trail in a specific time frame
Sense of personal and social responsibility:	taking responsibility for raising awareness in the wider community

LINK TO THE 17 SUSTAINABLE DEVELOPMENT GOALS

Goal#11: Sustainable Cities and Communities protection of urban and peri-urban green areas

Goal#15: Life on land promoting and protecting biodiversity

PHASES

PHASE 1: Introduction to the concept and issues of biodiversity

(2 teaching hours/school unit)

Brief description

In this phase, an attempt is made to actively involve and evaluate the students' previous knowledge and to create interest in dealing with the issue of diversity

in nature, with reference to the nearby ecosystem of Mount Hymettus.

Activities

1. Biodiversity of Hymettus

Watch the video "The Nature of Hymettus". While watching, the students, working in teams, record a) nouns, b) adjectives, c) verbs in relation to the images presented in the video. They present their notes in plenary and make sentences with word combinations. This is followed by a discussion about the variety of images (landscapes, flora, fauna). Goal: Introduce students to the concept of biodiversity.

2. Vegetation zones

Discussion about the vegetation zone to which Hymettus belongs: What are its characteristics? Explanation of the concepts of flora and fauna. What does it depend on? Connection with climate (6th Grade of Primary School Geography, Chapter 11 - Vegetation zones).

3. Introduction to the concept of endemic plants

Discussion on endemic plants: What they are, where we find them - examples, why they are important, what they are threatened by, etc. Are there any endemic plants on Hymettus? Reference to learning resources such as Phototree "Endemic Plants of Greece" and the articles "Flora of Hymettus" and "The Flora of Hymettus" from the website of the Association for the Protection and Development of Hymettus (SPAY).

PHASE 2: The concept of plant diversity in our immediate school environments

(field study) (4 teaching hours/school garden, nearby park)

Brief description

In the school garden or in the nearby park, the students engage in hands-on activities become introduced to the concept of biodiversity at the floral level. The activities in this phase familiarise students with the different characteristics

The Activities 1. Identilieaf, 2. Plant identification and observation key and 3. Plant identification with the Pl@ntNet application are presented in the DETAILED ANALYSIS OF SELECTED ACTIVITIES as Activity 1

of plants based on the principles of botanology. First, their interest in plant observation is triggered, then they attempt to categorise plants using an observation grid, and finally they test the corresponding categorisation using Pl@ntNetl.

Activities

1. Identileaf

The students, divided in teams, collect 5-8 different leaves from the school plants, give them fictional names and the other teams try to match the leaf with the new name. The activity aims to stimulate the children's imagination and motivate them to observe specific characteristics of plant leaves.

2. Plant identification with observation grid

At this stage, students are introduced to the scientific procedure. They undertake to identify the plants from the previous activity using an observation grid. Therefore, they become aware of the different species and how they differ from each other and, at the same time, become familiar with practices used by biologists.

3. Plant identification with the Pl@ntNet app (Citizen Science activity)

At this stage, the students confirm the identification of the plants using the Pl@ntNet platform. With the use of new technologies, students are encouraged to reinforce their understanding of biodiversity and, at the same time, they are introduced to the concept and practice of Citizen Science. They are informed about the identity of the Pl@ntNet tool (a participatory botanical observatory that collects and digitises a large amount of data entered by experts and nonexperts) and its usefulness.

PHASE 3: The concept of floral diversity in the forest

(field study) (7 teaching hours/nearby grove, forest, classroom, computer lab)

Brief description

In this phase, the students go to the suburban forest of Hymettus and, using the Pl@ntNet platform, identify the plants and evaluate the range of diversity. The aim is to make them aware of the great biodiversity of the forest ecosystem and to raise awareness for its protection.

Activities

1. Field study - recording and identifying flora (with the Pl@ntNet app) (Citizen Science activity)

At this stage, during a visit to a nearby park or forest (Hymettus), the students, divided in teams, define an area of one square metre. Within this surface they record plant species and try to identify them on Pl@ntNet platform. For each species they complete a worksheet entry (with the following information: possible name, special characteristics, e.g., smell, touch, drawing).

2. Addressing the issue of the biodiversity of Hymettus (Citizen Science activity)

Presentation to the assembly of the field work done in teams (after the photos are transferred from the camera to the PC and then uploaded to the Pl@ntNet tool, in case the devices used did not have a direct internet connection). Emphasis is placed on the variety of plants recorded, the frequency of occurrence of plants, their importance for the particular ecosystem, possible threats, etc.

3. Interview with a biologist

The possible questions posed by the students may require special knowledge, so an expert specialist biologist/forester is called in to provide a deeper analysis of the issue. At the same time, this also serves as an opportunity to introduce the profession of biologist and to enhance students' scientific literacy.

4. Leaf printing

In art class, using some leaves collected from the field, the students apply the technique of "leaf printing", which highlights the special characteristics of the leaves, and organise a mini exhibition of their creations.

5. Creating a digital puzzle

During the ICT class, using the photos of the plants they took in the field, the students create digital puzzles with the app https://www.jigsawplanet.com/. They choose different levels of difficulty (with few or many pieces), as the puzzles are intended for other students of all ages in the school. The puzzles will be accessible through the school website.

Possible extensions:

- Visit to the Diomedes Botanical Garden. The scientific classification of plants and its application in a garden with multiple functions (scientific, educational, recreational).
- Learn about the seed bank and its importance for biodiversity conservation.

PHASE 4: Promotion and protection of local biodiversity

(7 teaching hours/ school, park)

Brief description

In this phase, the students actively involve their knowledge on biodiversity with emphasis on flora and apply it to the creation of a trail in the school area, which aims to provide basic knowledge to other students and raise their awareness on the promotion and protection of biodiversity in the local environment.

Activities

1. Creating a biodiversity trail at school (Citizen Science activity)

The students lay out a path in the schoolyard, with stops at specific plants where the relevant explanations for each plant will be provided in the form of puzzles, riddles, verses, etc. The whole activity will be enriched with sensory activities, aimed at the entire student population.

2. Presentation to the public - Dissemination of the use of the Pl@ntNet app (Citizen Science activity)

The students organise the presentation of their trail to the school community, parents, and representatives of the Municipal Authority. They explain the stages of the preceding study, present the Pl@ntNet app, encouraging them to use it on their walks in Hymettus, or in any other ecosystem (groves, parks, municipal gardens, among others).

Activity 1. Creating a biodiversity trail in the school is presented in the DETAILED ANALYSIS OF SELECTED ACTIVITIES as Activity 2

EVALUATION

Creating a trail

The Phase 4 activity also functions as an evaluation process, since it can highlight the knowledge acquired through the implementation of the educational scenario, the particular attitudes formed, and the skills developed.

DETAILED PRESENTATION OF SELECTED ACTIVITIES

ACTIVITY 1

Title / Subject:	I observe and record diversity in nature
Platform / Citizen Science Tool:	Pl@ntNet
Duration:	4 teaching hours

AIM

With this activity, the students will be able to identify the parts of the plant that characterise its species (flowers, leaves, fruits, etc.).

OBJECTIVES

- Awareness of the diversity of species
- Reflecting on the value of biodiversity and the protection of different species
- Developing observation skills, pattern recognition, categorisation
- Familiarisation with new technology skills and the concept of artificial intelligence (photo recognition)

HOW THE STUDENTS ARE INVOLVED WITH CITIZEN SCIENCE

The students become familiar with the use of the Pl@ntNet digital observatory and feed data into the application, understanding its benefits. They take on the role of the non-expert in Citizen Science who observes and records data about the surrounding area.

Through this activity, they understand the natural environment in a broader way, develop botanical knowledge, link research on climate change, since the application enables long-term data recording and thus the recording of changes in flora due to climate change. They also realise the power of non-

experts in science and the contribution of ordinary citizens in identifying problems and providing solutions.

DETAILED DESCRIPTION OF THE ACTIVITY

Searching for the identity of the leaves (Identileaf) (stage 1)

This stage serves as an introduction to biodiversity with a focus on flora. The activity aims to stimulate children's imagination and motivate them to observe specific characteristics of plant leaves. The students are divided into teams with an even number of members. The students collect 10 different leaves from plants in the surrounding area (trees, bushes) and spread them on a sheet of paper or a board, tray, etc. They give the leaves fictional names inspired by shape, size, colour, etc. They then present their names in shuffled order to the other team, which tries to associate the pseudonyms with the leaves. A role swap follows. There is a discussion about what characteristics led them to choose the name and how easily they were led to the name/leaf match.

Plant identification with observation grid (stage 2)

At this stage, students are introduced to the scientific perspective. They become aware of the different species and how they can be distinguished and, at the same time, become familiar with practices used by biologists (observation/identification grid). Working in teams, the students try to identify herbs using the observation grid from the educational material of the EEC of Makrinitsa Handbook of botany: Basic knowledge-Worksheets. The teacher briefly explains the terminology used to describe the leaves of herbs and points out the relevant plants in the room (to facilitate the process, without naming them of course). If the students manage to identify the plants, the teacher encourages them to use the Pl@ntNet app to confirm their choice. Otherwise, in case the students have difficulty handling the grid, the teacher suggests the activity described below as an alternative (stage 3).

Plant identification with the Pl@ntNet app (stage 3)

At this stage, an attempt is made to use new technologies to enhance students' understanding of biodiversity. The Pl@ntNet app is used to demonstrate the extent of biodiversity and the active interest of scientists in raising public awareness of its protection. The students use the school tablets to access the Pl@ntNet app. They choose a plant feature (leaf, flower, fruit), photograph it and look for the plant's identity in the app, completing the previous activity.

They record their answers on a worksheet, including the name of the plant and a drawing. They can try additional identifications with other plant species.

A discussion follows on the following issues:

How much easier did the use of technology make it to achieve the purpose of your work?

What is the purpose of this app? Who created it?

Is it difficult to identify plants? Why?

What is biodiversity?

Is it important for life?

WAY OF ORGANISING THE CLASSROOM

The students will work in teams (even number of members in total, so that there is cooperation between the teams in pairs), they will present their work and then a plenary discussion will follow.

THE TEACHER'S ROLE

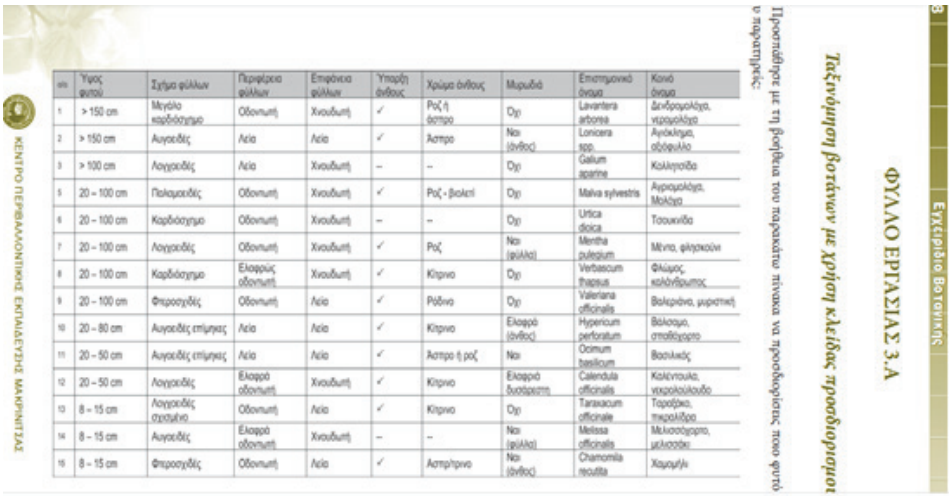
Moderator. He/she gives instructions for the activities, distributes equipment, explains the use of the Pl@ntNet app, guides the teams, and intervenes, where necessary, for encouragement and clarification.

NECESSARY INFRASTRUCTURE/EQUIPMENT

- Tablets / mobile phones (as many as the teams), ideally with internet connection. Alternatively, cameras, data cable, PC with internet connection.

ACCOMPANYING EDUCATIONAL MATERIAL / EDUCATIONAL MEDIA & TOOLS

A4 sheets of paper and glue to identify the leaves (stage 1)
Observation keys (as many as the teams) for stage 2, from the educational material of the EEC of Makrinitsa Handbook of botany: Basic knowledge - Worksheets.



ΚΕΝΤΡΟ ΠΕΡΙΒΑΛΛΟΝΤΙΚΗΣ ΕΚΠΑΙΔΕΥΣΗΣ ΜΑΚΡΥΝΙΤΣΑΣ

Εγχειρίδιο Βοτανικής

ΦΥΛΛΟ ΕΡΓΑΣΙΑΣ 3.Α

Ταξινόμηση βοτάνων με χρήση κλείδας προσδιορισμού

Προσπαθήστε με τη βοήθεια του παρακάτω πίνακα να προσδιορίσετε ποιο φυτό ο παρατηρήσες;

α/α	Ύψος φυτού	Σχήμα φύλλων	Περιθώριο φύλλων	Επιφάνεια φύλλων	Ύπαρξη άνθους	Χρώμα άνθους	Μυρωδιά	Επιστημονικό όνομα	Κοινό όνομα
1	> 150 cm	Μεγάλο καρδιόσχημο	Οδοντωτή	Χνουδωτή	✓	Ροζ ή άσπρο	Όχι	Lavantera arborea	Δενδρομολόχα, γερομολόχα
2	> 150 cm	Αυγοειδές	Λεία	Λεία	✓	Άσπρο	Ναι (άνθος)	Lonicera spp.	Αγιόκλημα, αζόφυλλο
3	> 100 cm	Λογχοειδές	Λεία	Χνουδωτή	–	–	Όχι	Galium aparine	Κολλητσίδα
5	20 – 100 cm	Παλαμοειδές	Οδοντωτή	Χνουδωτή	✓	Ροζ - βιολετί	Όχι	Malva sylvestris	Αγριομολόχα, Μολόχα
6	20 – 100 cm	Καρδιόσχημο	Οδοντωτή	Χνουδωτή	–	–	Όχι	Urtica dioica	Τσουκνίδα
7	20 – 100 cm	Λογχοειδές	Οδοντωτή	Χνουδωτή	✓	Ροζ	Ναι (φύλλα)	Mentha pulegium	Μέντα, φλισκούνι
8	20 – 100 cm	Καρδιόσχημο	Ελαφρώς οδοντωτή	Χνουδωτή	✓	Κίτρινο	Όχι	Verbascum thapsus	Φλόμος, κολόνδρυπος
9	20 – 100 cm	Φτεροσχιδές	Οδοντωτή	Λεία	✓	Ρόδινο	Όχι	Valeriana officinalis	Βαλεριάνα, μυρτική
10	20 – 80 cm	Αυγοειδές επίμηκες	Λεία	Λεία	✓	Κίτρινο	Ελαφρά (άνθος)	Hypericum perforatum	Βάλσαμο, σπαθόχορτο
11	20 – 50 cm	Αυγοειδές επίμηκες	Λεία	Λεία	✓	Άσπρο ή ροζ	Ναι	Ocimum basilicum	Βασιλικός
12	20 – 50 cm	Λογχοειδές	Ελαφρά οδοντωτή	Χνουδωτή	✓	Κίτρινο	Ελαφρά δυσάρεστη	Calendula officinalis	Καλέντουλα, νεκρολούλουδο
13	8 – 15 cm	Λογχοειδές σχιστόφυλλο	Οδοντωτή	Λεία	✓	Κίτρινο	Όχι	Taraxacum officinale	Ταραξάκο, πικρολάδο
14	8 – 15 cm	Αυγοειδές	Ελαφρά οδοντωτή	Χνουδωτή	–	–	Ναι (φύλλα)	Melissa officinalis	Μελισσόχορτο, μελισσάκι
15	8 – 15 cm	Φτεροσχιδές	Οδοντωτή	Λεία	✓	Λευκό/κίτρινο	Ναι (άνθος)	Chamomila recutita	Χαμομήλι

DELIVERABLES

- Data logging table: worksheet with the details of each plant (name, characteristics, drawing, if they knew it before, etc.)

EVALUATION

The following will be evaluated:

- The effectiveness of team work by the teacher, observing the degree of participation of the members
- The effectiveness of the use of the observation grid (the degree of difficulty of its use by students)
- The effectiveness of the use of the Pl@ntNet digital (how handy it was, how easily students learned to use it, how quickly it led to results)
- The students' interest in the topic, based on their level of engagement and questions/answers in the final stage of discussion on biodiversity

ACTIVITY 2

Title/Subject:	Creating a trail in the schoolyard
Platform / Citizen Science Tool:	Pl@ntNet
Duration:	4 teaching hours

AIM

The aim is for students to acquire knowledge about plants and the creative application of the knowledge acquired throughout the scenario.

OBJECTIVES

- Exploring the flora of the school, by creating a trail with stops at the plants in the courtyard
- Adopting plant-friendly attitudes and raising awareness about biodiversity protection
- Becoming familiar with the use and making the best use of the Pl@ntNet platform

HOW THE STUDENTS ARE INVOLVED WITH CITIZEN SCIENCE

The students use the Pl@ntNet digital observatory to identify the plants of the school in order to include them in an environmental biodiversity trail, which will be used by other students, in order to raise their awareness of plant diversity in the local environment. Also, by including the digital tool for use by other students, they multiply the concept of Citizen Science to a wider audience.

DETAILED DESCRIPTION OF THE ACTIVITY

Creation of an environmental trail

The students work in teams to mark out a trail in the schoolyard (or in a nearby park if the schoolyard is not available) to highlight local plant diversity. The trail is addressed to other students and aims to familiarise them with flora species, especially those found in the ecosystem of Hymettus. The idea behind the trail is to build stations at key points: plants that already exist in the area or others that will be planted for this purpose. Each station will provide knowledge to the students' classmates in an experiential way. The students suggest ideas for the name of the trail, but also for the activities it will contain, such as multiple-choice, true or false puzzles, anagrams, hidden treasure game, sensory activities about smells/textures, myths related to certain plants, etc.

Identification of plants

The Pl@ntNet app will be used for the initial identification of the plants in the area (to complement the previous activity). The app could be available via tablet for visiting students as well, in order to become familiar with its use and usefulness and to allow them to use it outside school.

WAY OF ORGANISING THE CLASSROOM

The work is presented in plenary and all the students' ideas and suggestions are synthesised. The students work in teams (of 4) on the construction of a specific part of the trail.

THE TEACHER'S ROLE

Guide. He/she gives instructions for the activities, guides the evaluation of the proposals on how feasible and effective they could be, and takes care of finding the materials needed to build the trail. He/she coordinates the teams and intervenes where necessary for encouragement and clarification.

NECESSARY INFRASTRUCTURE / EQUIPMENT

- Cards and sticks, for writing information/activities for the stations
- Materials for the construction of guide signs on the trail
- Tablet to use the Pl@ntNet app

DELIVERABLES

The biodiversity trail: a route through the schoolyard that will guide other students in an experiential way to the plants of the schoolyard (trees, shrubs, grasses, etc.).

EVALUATION

The degree of involvement of the students in the creation of the path with original ideas will be a decisive factor in the evaluation of the activity, as the main objective is the creative application of the knowledge acquired during the whole scenario.

SCENARIO 2

SCENT OF SCHOOL... SCENT OF NEIGHBORHOOD

Theologia Avdelli, Zacharenia Daskalaki, Matrona Pappa

Age tier:	Primary education (primary school, schools for children with specific needs). It is also addressed to children with visual impairments or learning difficulties.
Duration:	3 months (20 teaching hours)
Tool / Platform:	OdourCollect
Field:	school unit, children's surroundings and neighbourhoods
Keywords:	odour pollution, effects, school, local community, emotions, memories, sensory experimentation

Citation: © Avdelli, T., Daskalaki, M. & Pappa, M. (2023). Scent of School... Scent of Neighborhood. In M. Daskolia (Ed.) *Environmental Education for Sustainability and Citizen Science. Integrating environmental citizen observatories into school educational practice* (pp. 137-136). National & Kapodistrian University of Athens Press. https://doi.org/10.26247/nkuapress.ebook.2

BRIEF DESCRIPTION

The subject of the proposed scenario will be odour pollution in the school area and in the neighborhoods around it, where the majority of students who attend the school live. It is attempted to link Citizen Science with EE, through the use of OdourCollect, seeking and highlighting an interdisciplinary approach. The scenario examines the effects of unpleasant odours on economic and social life, the health of a neighbourhood's citizens, as well as issues related to social interactions, such as a walk with friends or a gathering in a square. Regarding the school space, special emphasis is placed on the feelings that children develop for their own school when they are forced to experience unpleasant odours every day. Therefore, the scenario investigates the extent to which odours influence the way children perceive their school space. The scenario suggests sensory walks in the indoor and outdoor areas of the school unit and in the areas around it, the use of the OdourCollect application, smelldiaries, and a series of playful activities and special sensory experimentation inside and outside the school unit. With the implementation of this scenario, children are expected to discover and highlight any problems and dysfunctions related to odours in the school and wider neighbourhood, in order to become carriers of change for the sustainable future of the school and their local community.

CONNECTION WITH CURRICULUM SUBJECTS

Language:	development of written and oral speech (describing thoughts, feelings, memories)
Mathematics:	extraction of percentages
Geography:	types of maps (map creation), the cardinal points, and orientation in space
Natural sciences:	respiratory system (the organs of the respiratory system)
ICT:	creation of blueprints and visualisation of research results, use of digital platforms (Odourcollect, Padlet) and digital devices (use of tablets, mobile phones, cameras)
Social and political sciences:	rights and obligations (protection of rights), participation in decision-making (researching, thinking, deciding, and acting as an active citizen)

LITERACIES

Environmental literacy

- understanding basic ecological concepts
- learning about "sustainable cities"
- local environment

Scientific literacy

learning about

- Citizen Science
- How breathing and smell work

Citizenship literacy

awareness

- of the need to inform the school/local community and search for solutions
- of their obligations/responsibilities towards the community for environmental protection
- of their active role in tackling emerging problems
- of the need to participate in active citizenship activities (community information, presentation and notification of actions, contact with the Municipal authorities/ letter to the Mayor)

Digital literacy

- use of the OdourCollect platform
- utilisation of digital technology
- use of digital tools for posters/presentations

Basic literacy

- writing (poems, short stories, creation of a questionnaire, letter to the Mayor)
- drawing (expressing feelings, thoughts)
- foreign languages (Citizen Science platforms)

GOALS / SKILLS

Creative thinking:	creation of comics, poems/songs writing (expressing emotions/memories)
	creation of a dance/ theatrical play performance to be presented to the school/local community
Critical thinking:	taking action to improve the school environment
	developing components, such as comparison, analysis, synthesis, argumentation
Problem-solving:	experiential way of familiarising oneself with the 7-step problem-solving method
Decision-making:	active citizenship with participation in decision - making
	selecting plants and planting sites in order to deal with the issues of unpleasant odours
	participating in the planning and organisation of activities, as well as in the dissemination of results
Learning how to learn:	creation of questions / queries by the children themselves according to personal/collective needs
	choosing how to search for answers and find solutions
	transforming the collective knowledge of the group, becoming familiar with it and consolidating it
Searching for and analysing information:	Internet
	local press
	libraries
	OdourCollect application
	local residents (discussions, questionnaire)
Communication of ideas and information:	publication in the local electronic press
	posting padlets on the school's website with the areas in which the students worked, photos per task stage, relevant material which will continue to be enriched
	in-person presentation to the school community (parents, guardians)
Collaboration - teamwork:	developing interpersonal relationships (team spirit, strength in unity)

Leadership and responsibility:	division of tasks sharing responsibilities assuming corresponding responsibilities
Developing initiatives:	greening the neighborhood and school with aromatic plants

LINK TO THE 17 SUSTAINABLE DEVELOPMENT GOALS

Goal#4: Quality education

Goal#6: Clean water and sanitation

Goal#11: Sustainable Cities and communities

PHASES

PHASE 1: Identifying odours in the school and in the neighbourhood

(6 teaching hours/school unit)

Brief description

Introduction to the issue of odours in the school and the neighborhood, the respiratory system, and the function of the sense of smell. Reflection on the existence of odours in the local environment and a first contact with OdourCollect. Through a series of playful activities and sensory experimentation, children seek to practice their sense of smell, recognising the diversity of odours, and, at the same time, connecting them with emotions, memories, and new tangible experiences.

Activities

1. Smell and guess (1 teaching hours)

Starting point - Odour recognition game (spices, vegetables, etc.) with closed eyes

Activity 4. School as a Space of Fragrances, Memories and Emotions is presented as ACTIVITY 1 in the section DETAILED PRESENTATION OF SELECTED ACTIVITIES below.

2. The function of the respiratory system and the sense of smell (1 teaching hours)

Acquisition of basic knowledge and clarification of concepts

3. Discussion on the odours of the local environment and introduction to basic concepts about the environment and sustainability. Presentation of the OdourCollect app (1 teaching hours)

Discussion and exchange of views on odours in the school and the neighbourhood and children's experiences of these odours. Construction of conceptual maps on causes, impacts, associated human activities, and proposed actions for the mitigation of unpleasant odours. Concept of sustainability. Presentation of OdourCollect.

4. Exploring school odours - School as a Space of Scents, Memories and Emotions (3 teaching hours)

Identification and recording of odours (pleasant and unpleasant) and imprinting emotions and memories in the school area. Use of the OdourCollect app.

PHASE 2: Citizen Science meets Environmental Education for Sustainability (EES): Study and showcasing of the subject

(11 teaching hours/school unit, neighbourhood)

Brief description

Children are encouraged to act as researchers by identifying problems and proposing solutions to odour issues in the neighbourhood and in the school environment. They become familiar with science and knowledge production processes (e.g., data collection and processing) using a variety of teaching techniques, practices, and tools (e.g., discussion with experts, research using questionnaires, observation and recording of cases with OdourCollect, creating calendars and an odour map).

This activity is presented in detail in the section DETAILED PRESENTATION OF SELECTED ACTIVITIES, as ACTIVITY 2.

Activity 1. Getting to know the neighborhood with OdourCollect and Activity 2. Utilisation of OdourCollect and odour logs is presented as ACTIVITY 2 in the section DETAILED PRESENTATION OF SELECTED ACTIVITIES below.

Activities

1. Getting to know the neighbourhood and OdourCollect
(2 teaching hours)

Sensory walks in the area around the school unit using the OdourCollect app and activities such as: filling in a worksheet (the creation of which is left to the teacher's choices) and taking pictures of spots with pleasant and unpleasant odours.

2. Use of OdourCollect and odour calendars (3 teaching hours)

Identification and recording of odours (unpleasant) in the places most frequented by students and at the same time familiarisation with the names of streets, open public spaces, parks and squares located nearby and where incidents with unpleasant odours are detected. The children are provided with a topographic diagram of the area on which they mark points of interest as they come across them. They also record their observations in odour diaries and create odour maps.

3. Visit of experts and discussion on the issue of unpleasant odours (2 teaching hours)

The children ask questions and queries: for example, the impact of odours on health, the economy, the environment, social life.

4. Research using questionnaires and discussions/personal testimonies with the family (2 teaching hours)

Creation and sharing of questionnaires to local residents and discussions/ oral testimonies in the children's family circle. Processing the responses and announcing the results with graphs on the school bulletin board.

5. Imprinting conclusions of ideas and proposals (2 teaching hours)

The children, divided in teams according to their interests, choose the way (visual arts, music, theatrical play, ICT, ppt creation, written speech) in which they will communicate their conclusions and proposals to the school and local community.

PHASE 3: Young citizens in action

(3 teaching hours/school unit)

Brief description

The children make decisions and act as active citizens, sharing their results and conclusions with the school and the local community in order to become agents of change for the sustainable future of their local community. In particular, emphasis will be placed not only on exploration (experience)/acquaintance (knowledge), but also on action by promoting changes in the school and the local community (planting aromatic plants, letter of notification of existing problems and results to the Mayor, dissemination of the children's actions and projects).

Activities

1. Conceptual maps (1 teaching hours)

Construction of conceptual maps on causes, effects, associated human activities, and proposed actions for the mitigation of unpleasant odours.

2. Go-go, gardeners!!! (1 teaching hours)

Planting of aromatic plants in the school yard.

3. Mr Mayor, can you hear us?

Contacting the Mayor/City Councilor, responsible for the Environment and Sustainability, in order for the children to send - via email - a letter with their conclusions and suggestions about the unpleasant odours of the area in search of solutions.

4. Let's share what we've learned, experienced, smelled... (1 teaching hours)

Presentation to the school community, post on the school blog, and creative activities on World Environment Day (5 June).

EVALUATION

Activities

1. Initial evaluation

A questionnaire is used to investigate the children's knowledge of smells and odours in their neighbourhood and school.

2. Interim - Formative evaluation

The purpose of this evaluation phase is to identify difficulties, problems, and unexpected events, and redefine the actions and time schedule. Specifically, at the end of each phase, it is suggested that the children use a checklist, prepared by the teacher, in order to ascertain the progress of the activities (what they have achieved and what has not been achieved), in order to make appropriate corrections and arrangements.

3. Final evaluation

A. Self-evaluation (4-3-2-1)

The children write 4 things they learned, 3 things they felt, 2 things they shared, and 1 thing they will never forget from the experience of being involved in this particular project. Then the entire group reflects in a circle on "what we achieved", "what we can do best", and "what we recommend as a team".

B. Evaluation by the teacher

The teacher, based on the notes s/he kept and experience gained, draws his/ her conclusions about whether the children developed transformative learning skills (critical thinking, problem-solving, system-based thinking, creativity, decision-making). He/she also discusses whether the particular scenario affected the climate of the class and the interpersonal relationships between the children.

DETAILED PRESENTATION OF SELECTED ACTIVITIES

ACTIVITY 1

Title / Subject:	Getting to know the neighbourhood and OdourCollect
Platform / Citizen Science Tool:	OdourCollect
Duration:	5 teaching hours

AIM

The aim is familiarisation with OdourCollect, as, on completing the activity, the children will be able to use the app and explain how the app helps them act as active citizens.

OBJECTIVES

- To come into direct contact with the neighbourhood and identify locations which should receive special attention in relation to odours.
- To participate and contribute to research, following the steps of a research process.
- To become familiar with and develop skills related to new technologies (IT literacy)

HOW THE STUDENTS ARE INVOLVED WITH CITIZEN SCIENCE

Through sensory walks, the students will identify and record the odours they encounter in the streets of the school's neighborhood and classify them into pleasant and unpleasant. They will then analyse their data and draw conclusions about the rates of pleasant and unpleasant odours in their area.

With the aid of the app, the children understand the value and recognise the usefulness of Citizen Science and new technologies in identifying and addressing problems in everyday life. Through this process, the children are empowered to act as active citizens to improve their local community's quality of life.

DETAILED DESCRIPTION OF THE ACTIVITY

The children will engage in sensory walks in the areas around their school using the OdourCollect app and creative activities by photographing spots with pleasant and unpleasant odours.

Formation of teams and instructions for students

The teacher divides the children into pairs. Each pair is given a map of the area, a worksheet, and three colour markers (red, green, and yellow) for observations based on the OdourCollect application. The teacher gives instructions for the conduct of the activity with emphasis on safety rules when walking around the neighbourhood. He/she explains that one child of the pair holds the map and uses it to mark on it pleasant odours in green, unpleasant odours in red, and neutral odours in yellow. The other child of the pair records on the worksheet

the street, the type of smell, its intensity, duration and geographical location, according to the four cardinal points. Roles are switched from time to time.

Sensory walks

Then, sensory walks take place (one or more sensory walks can take place, depending on the time that the teacher has at his/her disposal). The students will try to identify and record odours (pleasant and unpleasant) in the most frequented places and at the same time they will become familiar with the names of streets, open public spaces, parks and squares, which are nearby and where problems with unpleasant odours are detected. During the sensory walks, the student pairs take photos of points of interest related to odours, take turns to enter the data in the OdourCollect app, and, at the same time, record their observations in odour diaries.

Discussion of the findings

After the students return to school, they discuss in the schoolyard or in the classroom the general impressions gained from the sensory walk experience.
Possible questions for discussion:
Does our neighbourhood smell pleasantly rather than unpleasantly?
What kind of odour do we smell most often?
How does the specific kind of odour make us feel?
What do you think: can this odour affect life in our local community?
How can we find more information on this issue?

Organising the data and drawing conclusions

The teacher encourages the children to edit the data collected in the worksheet and to draw their results/conclusions in the form of percentages.

WAY OF ORGANISING THE CLASSROOM

The children are organised into pairs, as each member of the pair has a specific role; at the end of the activity, the children gather and discuss in plenary.

THE TEACHER'S ROLE

Moderator. He/she prepares the materials to be used, guides the children on the way they will work, coordinates the steps of the activity and the discussion of emotions and memories, and encourages children to express themselves creatively by utilising and evolving their skills.

NECESSARY INFRASTRUCTURE / EQUIPMENT

- Materials for recording odours: pencils, markers, worksheet
- Map of the area
- Internet and Googlemap access
- Odour-diaries
- Evaluation questionnaire

ACCOMPANYING EDUCATIONAL MATERIAL / EDUCATIONAL MEDIA & TOOLS

DELIVERABLES

- Producing an odour map of the school's neighbourhood
- Drafting odour-diaries

EVALUATION

The cooperation of students in pairs will be evaluated using a questionnaire.

ACTIVITY 2

Title / Subject:	School as a place of Scents, Memories and Emotions
Platform / Citizen Science Tool:	OdourCollect
Duration:	3 teaching hours

AIM

The aim is to get acquainted with the school environment and identify any odour problems that need immediate treatment.

OTHER GOALS

- To recognise spaces of special aesthetic pleasure
- To form a strong emotional involvement and bond with the school space

HOW THE STUDENTS ARE INVOLVED WITH CITIZEN SCIENCE

Through their tour in the area of their school, the students will record the odours they encounter and classify them into pleasant and unpleasant. They

will then connect them with memories and emotions that will emerge from them. Through the app, the children understand the value and recognise the usefulness of Citizen Science and new technologies in identifying and addressing problems in everyday life. Through this process, they are empowered to act as active citizens to improve the quality of the school environment. At the same time, they become familiar with and develop their skills with new technologies and develop their IT literacy.

DETAILED DESCRIPTION OF THE ACTIVITY

Recording and linking memories and experiences with odours

Using brainstorming the teacher, asks the children "What does the word 'odour' bring to mind?" and records their responses through the mentimeter application, which highlights the words that appear more frequently. By discussing in plenary, they find that an odour is often associated with the emergence of memories and invites individuals to experience a multitude of emotions. Thus, they are given the opportunity to start exploring odours in all areas of the school.

Odour detection and registration in the OdourCollect app

The teacher asks the children to form pairs and explains the process: One child is asked to be blindfolded with a handkerchief, and another child guides it. Where they detect an odour they stop; the child with the closed eyes must recognise the odour and the area of the school in which it is located. They then record it and link it to emotions and memories in the worksheet they have been given. At the same time, they introduce their comments in the OdourCollect application. Then, they swap roles so that everyone can have the same experiences.

Creative expression and connection of odours with the Arts

The children return to class and the teacher urges them, using the data they have recorded in the worksheets, to express their emotions and memories in a creative way (e.g., dramatisation, painting, dancing, singing, poetry).

Notification of the creations

The children upload their creations to the Padlet app so they can access their classmates' creations.

WAY OF ORGANISING THE CLASSROOM

The children, with the help of the teacher, organise themselves into pairs and alternate their roles during the detection of odours in their school, with the result that all children have the opportunity to experience exploration (with closed eyes) and participation in odour recording.

THE TEACHER'S ROLE

Moderator. He/she prepares the materials to be used, guides the children on the way they will work, coordinates the steps of the activity and the discussion of emotions and memories, and encourages children to express themselves creatively by utilising and evolving their skills.

Supportive. He/she encourages the children to express themselves freely and creatively, using their imagination, while children try to connect odours with the Arts.

NECESSARY LOGISTICAL INFRASTRUCTURE / EQUIPMENT

- Internet connection
- Computer, video projector, CD player
- Materials for recording odours: pencils, markers, worksheet, handkerchiefs
- Materials for the creative expression and connection of odours with the Arts: pencils, markers, paper, glues

ACCOMPANYING EDUCATIONAL MATERIAL / EDUCATIONAL MEDIA & TOOLS

- Worksheet, for the self-evaluation of their experience of participating in the activity
- Applications: Padlet and Mentimeter

DELIVERABLES

- Data entry into the OdourCollect app (school odours)
- The children's creations (e.g., dramatisation, painting, dancing, singing, poetry)

EVALUATION

The children take stock of school odours and evaluate the specific situation with emojis. They also use emojis again to express their experience of the activity.

NOTES - COMMENTS - INSTRUCTIONS

The children's creations, aside from the Padlet, on which they will be posted, can also be presented to the school community on World Environment Day or at the final school celebration.

ANNEX

Self-Evaluation Sheet

How did I work with my partner?

Name:..... Date: .....

TASK	 I contributed to the task and did the best I could.	 I contributed to the task but I didn't do the best I could.	 I didn't contribute to the task.
COOPERATION	 I cooperated and communicated with my partner throughout the activity.	 I cooperated and communicated with my partner at several moments of the activity.	 I did not cooperate nor did I communicate with my partner throughout the activity.
EFFORT	 I was focused on the task all the time and made a big effort.	 I was focused on the task at some times and made a fair effort.	 I did not concentrate on the task and did not make any effort.

Team self-evaluation sheet (can also be given in pairs)

Team Name:..... Date: .....

Task title: .....

Member names:.....

In your team, discuss the questions and decide which answer describes how you worked together. Then fill out the sentences.

Questions	Yes	No
We finished our task in the predetermined time frame and we are happy with it.		
We worked with each other very well.		
We encouraged each other.		
We exchanged our ideas all the time/often.		
We listened to other people's ideas carefully.		
We respected each other and talked to each other politely.		
What we did best was:		
Next time we work together we could improve:		

Team collaboration evaluation sheet

Team name:..... Date: .....

Member names:.....

.....

Read the suggestions carefully and rate them according to your own point of view and that of all members of your team.

1 = I strongly disagree, 2 = I disagree, 3 = I neither agree nor disagree, 4 = I agree, 5 = I totally agree

	My point of view	The team's point of view
All team members were actively involved in all its work.		
We all listened attentively to the opinions of all team members.		
Disagreements within the team were solved politely and by discussion.		
We placed great emphasis on the quality of our work.		
All members are satisfied with our cooperation and participation in the team.		

SCENARIO 3

MEMORIES OF FUNNELS, SHIPS AND AROMATIC PLANTS.

WE MAP THE FLORA AND ODOURS OF THE FORMER INDUSTRIAL SITE OF DRAPETSONA WITH PL@NTNET AND ODOURCOLLECT

Christos Godevas, Stavroula Triantafillou, Ioanna Fokou

Age range:	5th & 6th Grade of Elementary School / with adaptation for Middle School / High School & Long-life education / PWD participation possible
Duration:	3 months (24 teaching hours)
Tool / Platform:	Pl@ntNet, OdourCollect
Site:	former industrial site of the Drapetsona Fertilizer and Chemicals Factory
Keywords:	sustainable redevelopment of a former industrial site, human/industrial activities, air/odour pollution, mapping, thematic map, digital poster/postcard, local history, flora, school garden, aromatic plants and herbs, folk tradition, mythology, cross-cultural education, values and rights education

Citation: © Godevas,C., Triantafyllou, S. & Fokou, I. (2023). Memories of funnels, ships and aromatic plants. We map the flora and odours of the former industrial site of Drapetsona with Pl@ntNet and OdourCollect. In M. Daskolia (Ed.) *Environmental Education for Sustainability and Citizen Science. Integrating environmental citizen observatories into school educational practice* (pp. 155-187). National & Kapodistrian University of Athens Press. https://doi.org/10.26247/nkuapress.ebook.2

BRIEF DESCRIPTION

The scenario attempts to connect Citizen Science with EE with the use of the Pl@ntNet and OdourCollect COs. The students will be asked to create a thematic map of the former industrial site of the Drapetsona Fertilizer and Chemicals Factory (hereafter Fertilizer Factory) through an interdisciplinary perspective (physical and social sciences), in order to develop a proposal for the sustainable regeneration of the former industrial site. Drawing on local history, they investigate the flora of the area, the problem of odours and air pollution, and their interactions. According to the main methodological approach of the scenario, an attempt is made to frame the scientific paradigm of observations and measurements (Phase 1), as shown through the use of two COs (Pl@ntNet for plant/herb identification, OdourCollect for odour recording), with the education of values and rights (Phase 2), but also with popular culture regarding the topic of plants and herbs. The scenario in question can also be used, with the corresponding modifications, in the case of an interdisciplinary action plan on the formation of a school garden in the school yard. In addition, it can be used in an intercultural education project, to the extent that aromatic herbs/plants are a common theme of myths and legends of many different cultures, with the aim of creating a favourable environment for intercultural communication. The project includes activities in the field of the former industrial site (e.g., mapping, recording flora and odours with the applications Pl@ntNet and OdourCollect, respectively) and in the school area (e.g., creating a digital poster, digital postcards, thematic map).

CONNECTION WITH CURRICULUM SUBJECTS

ELEMENTARY SCHOOL

Language: written and oral communication (creation of a collective story, interview with the site wardens and interview with a expert scientist), direct and indirect speech (creation of questionnaires and interview questions), reasoning (causes of air pollution)

Mathematics: measurements and comparison of data (e.g., different temperatures and different direction of winds depending on weather conditions)

ICT: collaborative google documents, digital tools for creating postcards and digital multimodal and interactive posters, use of digital platforms (OdourCollect, Pl@ntNet, Padlet), searching for information on the internet (e.g., on the website of the

	Hellenic National Meteorological Service for temperatures and wind direction)
Social and political sciences	rights and obligations (protection of rights), participation in decision-making (researching, thinking, deciding, and acting as an active citizen)
Geography:	maps and topographical plan of an area
Natural sciences:	respiratory system (the organs of the respiratory system)

HIGH SCHOOL

Skills Workshops, Natural Sciences, Geography, Mathematics, Social and Political Education, History, Language, Technology

LYCEUM

Natural Sciences, Mathematics, Political Education, History, Modern Greek Language and Literature, Philosophy

Vocational Lyceum (EPAL)

Creative Activities Zone, Agriculture and Sustainable Development, Research in Technology, Natural Sciences

Life-long education

Linguistic, Social, Scientific, Mathematical, Environmental Literacy

LITERACIES

Environmental literacy

- acquaintance with the flora of the field
- identification of odours associated with air pollution in the area due to recent industrial activity

Scientific literacy

- introduction to the observation and data recording procedures through the two COs (Pl@ntNet, OdourCollect)

Citizenship literacy

- cultivating the value of shared responsibility and taking action
- awareness of the function of a former industrial site as an environmental and social good for the local and wider community
- organisation of an event to inform and raise awareness for the purpose of redeveloping the former industrial site of the Fertilizer Factory

Digital literacy

- practice entering data into two COs (Pl@ntNet, OdourCollect)
- familiarity with collaborative google docs, digital postcard creation tools, and digital multimodal and interactive poster
- posting of digital creations in a padlet environment

GOALS / SKILLS

Creative thought:	creating a thematic map with constructions, visual impressions, photographs creating a team story creating questionnaires and digital postcards in order to involve the local community
Critical thinking:	assessing the causes of air pollution identifying incompatible uses of the Fertilizer Plant studying existing regeneration proposals and identifying convergences and divergences
Problem solving:	formulating regeneration proposals by investigating the opinions and perspectives of the local community (questionnaire) and publishing them
Decision making:	choosing how to make the results public
Learning how to learn:	the scenario follows exploratory / discovery-led social learning processes
Searching for and analysing information:	mapping the flora and odours of the area through the two COs and analysing their interactive relationships by looking for information about the use of the site and the recent industrial activities of the area

Communication of ideas and information:	sharing ideas through a digital tool for creating multimodal posters and digital postcards collaborative documents social media to publish the classroom wall
Flexibility of thought and adaptability:	actions to give publicity to the problem of air pollution highlighting the area of interest with digital cards with the flora of the area highlighting the points of historical interest (the production units as traces of the recent industrial heritage)
Collaboration - teamwork:	working in teams and reallocation of teams developing partnerships cultivating the skill of cooperation and exercising democratic dialogue
Leadership and responsibility:	responsible action to address the problems of the local society (re-emergence of heavy industrial activity in residential areas next to a space that, after long-term mobilisations and claims, was given to the residents in the form of a shared public space that allows them access to the sea front)
Developing initiatives:	choosing ways to disseminate the issue of air pollution and the need to solve it (digital postcards, social media, etc.)
Project production and consistency in execution:	creation of a map with a specific task execution schedule
Sense of personal and social responsibility:	cultivating sensitivity and social responsibility for the issue of the degradation of a public common space that recalls the recent and very important industrial heritage of the area

LINK TO THE 17 SUSTAINABLE DEVELOPMENT GOALS

Goal#3: Good health and well-being
Goal#4: Quality education
Goal#5: Gender equality
Goal#7: Affordable and clean energy

Goal#8: Decent work and economic growth
Goal#9: Industry, innovation and infrastructure
Goal#10: Reduced inequalities (possibility of participation of students with disabilities)
Goal#11: Sustainable cities and communities
Goal#12: Responsible consumption and production
Goal#13: Climate action
Goal#14: Life below water
Goal#15: Life on land
Goal#17: Partnerships for the goals

PHASES

PHASE 1: Mapping the area / creation and processing of a thematic map

(12 teaching hours/classroom, Fertilizer Factory, Environmental Education Centre (EEC) of Drapetsona, school)

Brief description

The students are divided into teams (natural and social scientists). Brainstorming takes place stimulated by an aerial photograph of the research field and the wider area. They are then briefed on the deliverable of the scenario (formulation of redevelopment proposals for the former industrial site). In the first phase of the scenario, the teams are asked to "map" the space and carry out different sets of activities (Phase 1). They then create thematic maps and compose them into a single map, which they further elaborate with visual interventions, constructions with simple materials, etc. The map presents the conclusions of the field study (trees, plants, herbs, odours), highlights the relationships between the different findings (biodiversity and odours), as well as the contrast created between the uses of a space constituted as a public common space (with a theatre, footpath, stadium, etc.) and recent industrial activity (oil processing boilers from ships).

The activities of the Team of Natural Scientists in the field are presented as ACTIVITY 1: Mapping plants with the Pl@ntNet tool and ACTIVITY 2: Why do you have such a big nose? To smell better - Recognising odours in the DETAILED PRESENTATION OF SELECTED ACTIVITIES below.

Activities

1. Physical and Social Scientists in action

(8 teaching hours/EEC of Drapetsona, Fertilizer Factory)

The students visit the EEC of Drapetsona for information about the former industrial site of the Fertilizer Factory. In the field the sub-teams of Natural Scientists identify and study the flora of the area using the Pl@ntNet application and the odours with the OdourCollect application, respectively. Social Scientists record human activities in the field and the wider area by photographing and taking notes.

a) Natural Scientists:

The activity includes a visit to the EEC of Drapetsona and three visits to the field of the former industrial area. The students are divided into two sub-teams.

(i) Plant mapping with the Pl@ntNet application

Based on Aesop's fable "The lion, the wolf, and the fox" (Annex 1a), the first sub-team locates and records the flora (trees, plants, herbs) of the field in the Pl@ntNet application. The students mark on a topographical diagram of the former industrial area the points where the flora was located and fill in Worksheet 1.

At the EEC of Drapetsona, they create an A-to-Z of trees, plants, and herbs based on the information they collected, and digital postcards with their photos, through the crelloapplication.

(ii) Odour mapping with the OdourCollect tool

The students of the second sub-team are given pictures to locate the depicted points in the field. The students then register the odours and their source using the OdourCollect app. The registered points are also recorded on the topographic map where the photos with the students' notes are also placed.

The students interview an expert scientist about the operation of the air pollutant measuring station next to the ships' oil treatment tanks which emit very unpleasant odours.

At the EEC of Drapetsona, information is provided on the limits set by the European directives and a comparison with the values of the station. The students complete Worksheet 2 by correlating the odours with the wind conditions in the area at different times (south wind, north wind, no wind) and with the photographs from different parts of the field on the topographic map, identifying the source or sources of the unpleasant odours.

b) Social Scientists:

The activity includes a visit to the EEC of Drapetsona and up to three visits to the field of the former industrial area.

At the EEC of Drapetsona, the students are informed about the recent industrial history of the Fertilizer Factory, taking notes, on the one hand to inform the team of natural scientists at a later time, on the other hand to map the field and create their own thematic map.

They then visit and study the field, take photographs, take notes on traces of human activity (old and recent), supplementing their own topographic map where necessary, and interview local residents.

2. Recording observations and completing topographic diagrams (2 teaching hours/school)

At the school, the teams collect the topographical diagrams with the photos and observations and compose them. This activity presupposes the rearrangement of the initial teams, with the result that the new teams that result have members from both teams (natural and social scientists), so that there is detailed information on what has happened before. The individual topographic maps that were completed from the point of view of the natural scientists are then completed from the point of view of the social scientists and vice versa. Two thematic maps result, which are presented in plenary, compared and commented on.

3. Creating and editing a common thematic map (2 teaching hours/school)

A common thematic map is created, in which the photographs are integrated, and which records the main observations of the teams using simple materials (sticks, plasticine, etc.) and a synthesis is made between the observations concerning the flora, odours, and human activities in the area.

PHASE 2: Digitisation of the thematic map, processing proposals for the regeneration of the site & publication

(12 teaching hours/school, house, assembly hall of the school and/or Municipality)

Brief Description

The teams digitise the shared thematic map and embed it into a digital poster along with photos/videos from the field with their notes, field study findings, and conclusions.

The teams are then informed about the proposals for the regeneration of the former industrial area, which they process by creating concept maps which they present to the assembly.

The students are informed about the issue of integrated environmental management of public spaces, draw up a questionnaire for the local community, process it and come up with their own proposal.

Lastly, with the help of the Municipality, they organise an open event with the aim of publicising the results of their research and their proposals.

Activities

1. Create a digital poster (2 teaching hours/school)

The teams create a digital poster with the glogstertool. On the poster they embed their map with photos (plants/herbs, buildings, old industrial activity, recent redevelopment, odour recording points) and captions with their observations and/or hyperlinks to myths, fables, songs, riddles, etc. for the herbs of the region.

2. Regenerating the space: the previous proposals (2 teaching hours/school)

The teams are informed about the proposals for the regeneration of the former industrial site, they process them by creating concept maps that capture the advantages and disadvantages (ecological, social, economic) of each proposal, the points of convergence or divergence between them, etc.
They then locate the partially implemented redevelopment proposal in the social scientist team's photographs and incorporate it into their map.

3. Regenerating the space: creation of a regeneration proposal in accordance with the integrated management criteria (4 teaching hours/school)

The teams are informed about the issue of integrated management of public spaces and draw up a questionnaire for the local community to explore opinions, different proposals for redevelopment or improvement of existing projects, etc. They then go on to process the results. The teams arrive at their own proposal based on their research, as shown in their thematic map, on the principles of integrated management of public common spaces and taking into account the views of the local community.

4. Publishing the results (4 teaching hours/school, municipal area)

In collaboration with the Municipality, the students organise an open event to publish the results of their research and proposal, aiming to contribute to a comprehensive regeneration of the space. They create invitations and upload their digital poster to social media to publicise the event. They enrich the digital postcards they created in Phase 1 with photos of past and recent human activities, which highlight the regeneration proposal they have formulated to raise public awareness. The invitations, posters, and postcards are sent to the Municipality, institutions, and schools. The event takes place at the predetermined place and time and closes with a discussion on the regeneration of the former industrial site.

EVALUATION

Evaluation activities:

1. "My visit to the plant" bingo

By means of the bingo game, the students use the information they obtained from their visit to the field and from the Pl@ntNet app (up to 50 words).

2. "What did I learn?"

Each student notes in a few words or even better key words what he/she learned after each activity of the project.

3. The students' portfolios

The student maintains a date-based portfolio, in which he/she records work samples, feedback comments, photographic and other material, etc. The portfolio can also contain a record of the student's personal thoughts and concerns. The portfolio is completed at the end of an activity or on conclusion of a phase or at the end of the project.

4. Questionnaire

The questionnaire aims to record not only what the students gained from the project, but also how they cooperated in the teams. It also records the students' impressions from their acquaintance with the two platforms Pl@ntNet and OdourCollect, as well as their intentions about using them again in the future.

DETAILED PRESENTATION OF SELECTED ACTIVITIES

ACTIVITY 1

Title / Subject: Plant mapping with the Pl@ntNet application

Platform / Citizen Science Tool: Pl@ntNet

Duration: 6 teaching hours

AIM

The students make use of tools for Citizen Science and become little scientists who approach with a specific method the topics and questions, such as the flora in the former industrial area and its importance for the ecosystem and the local society.

OBJECTIVES

- to identify the flora of the former industrial site of the Drapetsona Fertilizer and Chemicals Factory
- to understand the value of flora for the local community, but also for human activities (medicine, pharmacology, cooking, confectionery, etc.) and the ecosystem
- to get to know and become familiar with the Pl@ntNet digital platform and its utilisation for the benefit of the local and wider society
- to strengthen interpersonal relationships between students with the common goal of acquiring knowledge
- to develop digital skills when creating digital postcards with a theme inspired by the flora of the region

HOW THE STUDENTS ARE INVOLVED WITH CITIZEN SCIENCE

Following a transition-driven-civic science, the students.... students take the initiative and the responsibility to construct new knowledge in collaboration with the scientists, highlighting the flora of the area. The students focus on the real problems posed by the regeneration of former industrial space and defending it as a public environmental and social good, a space that, due to complex ownership regimes, cannot yet integrate, protect, and highlight its recent industrial legacy. The goal is the practical improvement of their daily life through the observation and recording of the flora of the area, the use

of the CO Pl@ntNet, the investigation of the data of the platform from the point of view of its importance for the ecosystem and human activities and needs (conceptual mapping of the trees and plants they identified on the platform). The students are not only involved in activities involving observing and recording the flora, but at the same time they are emotionally activated by creating their own thematic maps, where they record the state of the flora, thoughts, feelings, values in the form of notes that they keep on their topographic map and which will form one of the contents of their thematic map. In this way, they strengthen their relationship with the place (Annex 2d) through their lived experience with it.

DETAILED DESCRIPTION OF THE ACTIVITY

The students brainstorm and divide into teams. The brainstorming is based on an aerial photograph that shows the crucial role of the former industrial site of the Fertilizer Factory for access of the local community and of the neighbouring municipalities to the sea. Then, as part of an educational trip to the EEC of Drapetsona, they visit the nearby fertilizer park (one of the areas that have been given for regeneration), in which herbs and aromatic plants have been planted in recent years by the Municipality of Keratsini-Drapetsona in a joint action with the EEC of Drapetsona. Each team has a Worksheet, a pen, a tablet with internet connection, and a stylus.

Investigating prior knowledge

The teams sit in the theatre around their teacher and members of the educational team of the EEC of Drapetsona. A member of the teaching team recounts the myth of Aesop named "The lion, the wolf, and the fox" (Annex 1a), highlighting the plants and herbs found in the plot and showing relevant photos (Annex 1b). The students note which herbs or aromatic plants from the fable they recognise in the pictures. Their answers are recorded and discussed in plenary.

Environmental trail

The teams follow the route from the little theatre to the Krakaris pier (next to Gate E1) (Figure 1). They identify and photograph the plants and herbs highlighted in the fable, but also photograph other species of local flora. They locate and mark the shooting points on their topographic map and take notes (condition of plants and trees, etc.). It is intended that they also take general shots (coast, buildings, etc.).

Use of the Pl@ntNet platform

After receiving information on how to register on the platform, the teams upload their photos and start identifying the plants. They combine the information provided by Pl@ntNet on the scientific names of the plants with that they gathered and and the common names for each plant. They validate and confirm their observations on the platform. They fill out the table in Worksheet 1 (Annex 1b).

Presentation to the assembly

On their return from the EEC of Drapetsona, the topographical maps of the teams are presented and compared with each other. Their similarities and differences are highlighted.

Creating an A-to-Z inventory

Each team creates an A-to-Z inventory of trees and plants (Annex 1c), in which they also include their photos and posts it on the class padlet, for the rest of their classmates to submit comments and impressions. They present the inventory to the assembly and it is compared and commented upon.

Mapping the importance of the area's flora

In the classroom, the teams investigate the usefulness of the flora of the field in terms of their value for the ecosystem and its uses in human practices (medicine, pharmacology, cooking, confectionery, etc.). The teacher invites the teams to answer a hypothetical question ("What would happen if there was no flora in the field?")and to note the possible consequences on their topographic map.

Creating digital postcards

The teams use the photos from the field trip and create digital postcards by logging into the crello app. A presentation is created in powerpoint or the prezi presentation software, which is also posted on the classroom digital wall.

Creating a team story

The teams create a collective story using collaborative google docs and incorporating into their story some of the flora they have identified, as well as photographs that capture traces of human activities in the field. Each team

member writes three lines which are continued by the second team member and so on. The story can be performed in a number of ways (narration that goes up on the class padlet, dramatisation/pantomime that other teams are asked to guess, artistic illustration, etc.).

WAY OF ORGANISING THE CLASSROOM

Throughout the activities, the team members alternate roles (in pairs they hold the topographic map, take pictures, make notes on the topographic map, make a presentation to the assembly, etc.). In addition, and for the best feedback on the activities, there is an alternation throughout between group-assembly, assembly-group.

THE TEACHER'S ROLE

Facilitator: He/she contributes to the teaching process as a coordinator of activity and feedback.

Mediator: He/she supports the activity as a mediator between the knowledge to be discovered and the students and is a step behind throughout the activity so that the students have the space and time to act on their own, take initiatives and experience the implementation of the activity.

NECESSARY INFRASTRUCTURE/EQUIPMENT

- Pencils
- Pens
- Tablets or smart phones with an internet connection
- Camera

ACCOMPANYING EDUCATIONAL MATERIAL / EDUCATIONAL MEDIA & TOOLS

- Aerial photography
- Topographical map
- Worksheet

DELIVERABLES

- Data logging table
- A-to-Z inventory of trees and plants of the area
- Thematic map
- Digital postcards
- Collaborative story

EVALUATION

The level and quality of cooperation of the students in the teams will be evaluated with questionnaires and their knowledge gained with a bingo game of trees and plants.

ANNEX

WORKSHEET 1

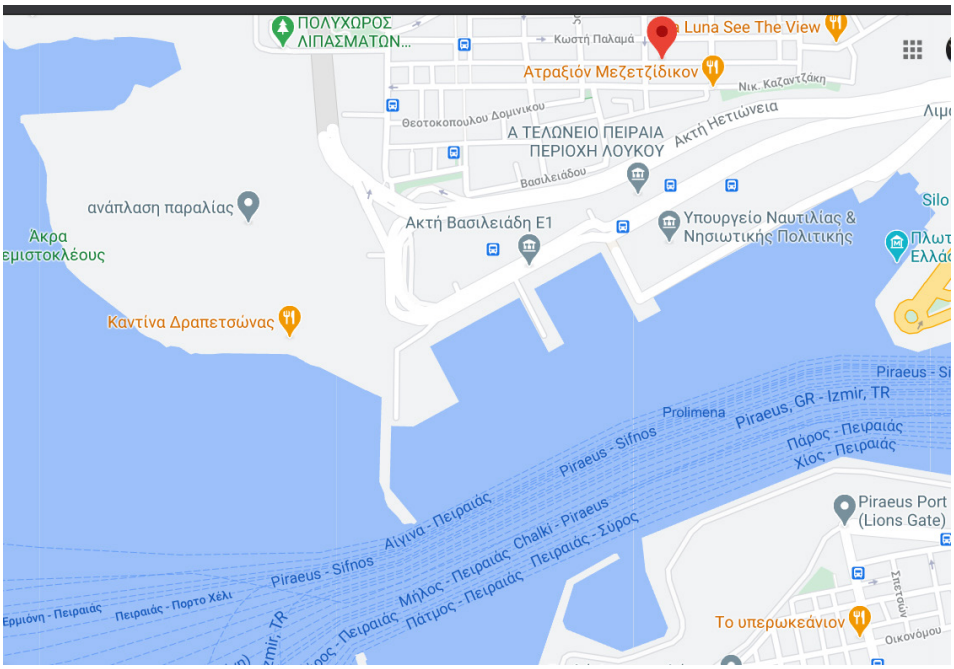


Figure 1

1. Locate with your team our exact position on the aerial photography.
2. Observe Figure 1. Locate where the study area is located (former industrial site of the Drapetsona Fertilizer and Chemicals Factory).
3. Discuss in pairs what caption you would give to Figure 1. In plenary, each team presents its captions. The teams decide together on the most appropriate caption.
4. Let's start from the area of the Keratsini-Drapetsona Municipality's regeneration, at the Polychoros Lipasmata (theatre) and listen to a fable (Annex 1a). Note down the plants and herbs mentioned in the fable. From the photographs given to you, try to identify which of the aromatic plants and herbs are mentioned in the fable (Annex 1b).
5. Follow an environmental path from the Water Tower to gate E1 and identify the plants and herbs mentioned in the fable. Take pictures, number the pictures, and locate the shot points on your topographic map (Figure 1).

6. Take pictures of the rest of the flora you come across, locating it on your topographic map. Take notes on the condition of the plants and the environment. Make sure there are also general shots of the surrounding area (coast, buildings, etc.).
7. Identify the species with the help of the Pl@ntNet application and complete your table (Annex 1b). Also record the scientific name of your finding.
8. Create an A-to-Z of your findings (trees, herbs and plants) (Annex 1c), including the photographs you have taken. Post it on your class padlet and invite your classmates from other classes or departments to post their impressions.
9. Consider the significance of the flora you have recorded for the area, i.e. the benefit in terms of the ecosystem, but also in terms of human activities (medicine, pharmacology, cooking, confectionery, etc.). What if there was no flora at all in the study area? Imagine the possible consequences and record them on your topographic map.
10. Create your own digital postcards with the crelloapp, using the photos you've taken.
11. Create a team story using a collaborative google doc. Choose 5-6 trees or plants you encountered on the environmental trail. Take turns to narrate with three lines each. Upload the final result to your classroom's digital wall. Choose other ways of performing your story, as well (artistic illustration, dramatisation/pantomime that the other teams have to guess, etc.).

ANNEX 1a

The Aesop's fable "The lion, the wolf, and the fox" is told by the animator/storyteller, while as a fox she takes out the different herbs from the bag, holds them, shows them, smells them.

The lion, the wolf, and the fox

In the old times, all the animals gathered in one place and held a council to choose a king. All the animals agreed that the bravest animal was the lion and that he should be their king. They then put the crown on the lion's head and he became king. From then on, the lion reigned for many, many years and no animal dared to challenge his authority.

At some point the lion got very sick and fell on the bed, roaring from pain and complaining about the evil that befell him. All the animals came by to see their sick king and wish him well. However not all animals went to see

him because they cared for his precious health; rather, they went because they feared his wrath when he got well. They couldn't give him a reason to accuse them that they didn't go to see him and punish them, they couldn't give him a reason to think that they didn't care about him.

One day the wolf, a white wolf, went to see the lion. As he was heading that way, he met the fox on the road and said to him:

- Good morning, dear Fox. I am going to see our beloved king who is ill. Are you coming?

- Good morning, dear Wolf. I'm not going anywhere. Why should I go see the lion? it's not like he's better than me so that I have to go and fall at his feet. Let him fall at mine.

The wolf did not answer and continued on his way. In fact he was glad that he was going on his own and that he would get to tell the lion: this is what the fox said about you, Your Majesty". He was walking and he was glad, he was glad and he was walking. The Fox thought he saw something in the wolf's expression and followed him to see what he would tell the lion when he saw him.

The wolf got to the lion's residence, went in, and sat by the lion. The fox hid behind a curtain and listened in. After a while, the lion said: My dear wolf, almost all animals have been to see me; the only one who has no yet made an appearance is the Fox.

The wolf seized the opportunity and said to the lion: God bless you, my king. On my way here, I saw him and told him: "Let's go see our beloved king; let's see how he's doing. To which he replied, "Why should I go and fall at his feet? It's not like he's better than me. Let him come and fall at mine."».

The lion then roared so loudly that half the forest shook and said: If I just had an hour alone with him... I know exactly what I'd do to him!

As soon as he heard these words, the fox disappeared from the face of the earth for a few days. And then the other animals saw him going straight to the lion's den, dragging a sack full of something.

As soon as the fox gets there, he goes in, bows down to the lion and says: My king, long may you live; may your good health return to you soon. And the lion replies: Where have you been all these days? Why didn't you come to see me?

Wait till I tell you where I was, your Majesty, said the fox. As soon as I heard you were bedridden, I looked for the best doctor and was told of one, in a place far away from here. So I went to find him. But, when I found him, since I wasn't sure of exactly what ailed you, he gave me medicine for every kind of pain.

He opens the sack, begins to take stuff out and says:

- Do you have an earache? Take this, boil it and add a few drops of achillea or yarrow and you'll be fine.

- Is an infection bothering you? If so, make a celery infusion and you'll be fine.

- Does you eye hurt? If so, boil chamomile, make eye compresses and you'll be fine.

- Do you have a sore throat? If so, gargle with sage and you'll be fine.

- Do your many worries as a king rob you of your sleep? If so, boil linden, drink it and you'll be fine.

- Are you burnt and in pain? If so, take comfrey or cuckoo-pint, pour the juice on the burn and you'll be fine.

- Are you upset and roaring furiously all the time? If so, boil and drink valerian and you'll be fine.

- Does your heart ache? If so, boil honeysuckle or lemon balm, drink it and you'll be fine.

- Do you have a tummy ache? If so, boil basil, drink it and you'll be fine.

- Do you have warts? If yes, boil calendula or marigold, put it on them and you'll be fine.

- Do you have wounds? If so, sprinkle dry rosemary on the wound and you'll be fine.

- Do you have kidney stones? If so, boil rustyback, drink it and you'll be fine.

To make a very long story short, the fox kept taking things out of that sack, more things, took it out, and then some more...until the sack was empty.

In any case, my king, said the cunning fox, if you want to get well sooner, the doctor told me that we should cut a white wolf in half and wrap you with its skin.

After taking the herbs, the lion ordered that the wolf be slaughtered and that he be wrapped in its skin. When he was feeling better and roared again as he used to, he used to say:

- Oh, that evil wolf! The Fox was so good to me and the wolf was going to hurt him!

Megas, G., A., *Greek Fairy Tales, Vol.2*, "Estia" Bookstore I.D. Kollarou and Sia S.A., 1994

ANNEX 1b

PHOTOGRAPH	SCIENTIFIC NAME	COMMON NAME	LOCATION POINT
	Eucalyptus globulus	Eucalyptus	Across from the former power plant

ANNEX 1c

The A-to-Z inventory of trees and plants. I find a tree or plant for each letter of the alphabet

A .....
B .....
C .....
D .....
E .....
F .....
G .....
H .....
I .....
J .....
K .....
L .....
M .....
N .....
O .....
P .....
Q .....
R .....
E .....
T .....
U .....
V .....
W .....
X .....
Y .....
Z .....

ACTIVITY 2

Title/Subject: Why do you have such a big nose? To smell better - Recognising odours

Platform / Citizen Science Tool: OdourCollect

Duration: 6 teaching hours

AIM

The students acquire tools for Citizen Science and become little scientists who use a specific method to approach the researched object, the unpleasant odours in the former industrial area, their effects on the environment and humans, and their relationship with quality of life.

OBJECTIVES

- to recognise the different odours present in the study area (former industrial site of the Fertilizer Factory)
- to correlate the different odours with human activities in the area (such as the factory emitting unpleasant odours from the processing and recycling of burnt oil from ships)
- to promote a collaborative climate for the discovery of knowledge and the creation of a group story
- to acquire information on the European legislation regarding the limits of gaseous pollutants in residential areas
- to identify within the study field points that show convergence or deviation from the European gas pollutant limits
- to conduct a structured interview with an interview guide
- to become familiar with the OdourCollect platform and its use, so that the students themselves contribute to a global community of citizens and their awareness of the environmental problems of their area

HOW THE STUDENTS ARE INVOLVED WITH CITIZEN SCIENCE

Students build new knowledge together with scientists, focusing on the real problems posed by the redevelopment of a public space. In particular, they focus on problems that afflict the local community and which have to do with the stench from the heavy industrial activity of processing oil from ships, which is right next to the area that has been redeveloped by the municipality (with a

small theatre, promenade, stadium, canteen, etc.) in the former industrial area of the Drapetsona Fertilizer Factory. They record the odours, identify the source of the unpleasant odour in collaboration with expert scientists who explain to them how the gas pollutant measurement station works in the redevelopment area and use the CO OdourCollect platform. The students are not only involved in activities involving observing and recording the odours, but at the same time they are emotionally activated by creating their own thematic maps, where they record odours in conjunction with the state of the flora that they have observed in a previous activity, thoughts, feelings, values in the form of notes that they keep on their topographic map and which will form one of the contents of their thematic map. In this way, they strengthen their relationship with the place (Annex 2d) through their lived experience with it.

DETAILED DESCRIPTION OF THE ACTIVITY

The activity is completed in three visits to the site of the former factory.

Odour mapping

Students visiting the former industrial site of the Fertilizer Factory are provided with Worksheet 2 and are tasked with identifying odours. Walking on the path of the park (from the little theatre to the Krakaris pier), they first go through the place where there are herbs and other plants and trees. They smell and record odours, identify the points depicted in photographs, take their own photographs which they locate on their topographical map, and make notes on it about the odours. They also walk past the ships' burnt oil treatment tanks and detect if something smells and how, they record it.

Conducting an interview with an expert scientist

The university has installed an air pollutant measurement station in front of the tanks, which measures how much pollution is emitted by the ship oil recycling plant. The students record it and have already prepared questions for the interview (interview guide) with an expert scientist from the university who will explain to them in simple terms what and how the specific device measures and will answer their questions. In particular, the expert explains to them how the smell is objectified by measurements of PM2.5 and PM10 suspended particles, tropospheric ozone, nitrogen dioxide, and sulfur dioxide.

Case study

They are informed about the maximum emission levels of air polutants in accordance with the European directives, compare the values recorded by the measuring device with the limits set by the European directives, and comment on the health effects and the degree of dispersion in the surrounding area. The answers are recorded by the teams.

Conducting an interview with site guards

They then interview the site guards, who answer their questions about what it smells like, whether it smells nice or bad, and whether there are days when it smells more or less depending on the direction of the wind (north, south, no wind). The answers are recorded in Worksheet 2.

Field study at repeated intervals

The students who have identified the heavy and unpleasant odour emitted by the ship oil treatment tanks, with the help of the forecasts of the Meteorological Service, visit the site twice more, so that they have data with north, south wind and no wind, to see if the odour is getting more or less unpleasant. The findings are entered in a table and analysed in plenary.

Use of the OdourCollect Platform

The students use the OdourCollect application (about which they have received information) and register the odours with geolocation (type, intensity, hedonistic tone, source, duration of smell).

Presentation to the assembly and enrichment of thematic maps

The students present to the assembly and discuss how people's activities are a source of odours and affect the environment, but also the quality of life of the local community. The results are reflected in the thematic map, which is also enriched by the previous activities.

WAY OF ORGANISING THE CLASSROOM

The students alternate in the format teams/assembly, assembly/teams.

THE TEACHER'S ROLE

Facilitator: He/she contributes to the teaching process as a coordinator of activity and feedback.

Mediator: He/she supports the activity as a mediator between the knowledge to be discovered and the students and is a step behind throughout the activity so that the students have the space and time to take initiatives and experience the implementation of the activity.

NECESSARY INFRASTRUCTURE / EQUIPMENT

- Pencil
- Pens
- Tablets or smart phones with an internet connection
- Camera

ACCOMPANYING EDUCATIONAL MATERIAL / EDUCATIONAL MEDIA & TOOLS

- Map of the area
- Worksheet

DELIVERABLES

- Data logging table
- Interviews
- Thematic map

EVALUATION

The cooperation of the students in the teams will be evaluated with questionnaires.

NOTES / COMMENTS / INSTRUCTIONS

The activity should be very well prepared; the teacher must have done preliminary work for the interviews with the guards, as well as with the expert scientist. A search must have been made on the website of the Meteorological Service for temperatures and wind direction, so as to carry out site visits in different weather conditions, make the necessary comparisons, and record the results.

ANNEX

WORKSHEET 2

1. Identify with your team the points shown in the photographs (Annex 2b).
2. Record odours in the field, take notes, and mark the points on your topographical map (Annex 2a).
3. Create an interview guide for your interview with an expert scientist to understand how the pollutant gas measurement station located on the former industrial site works:

A. Question: .....

.....

Answer: .....

.....

B. Question: .....

.....

Answer: .....

.....

C. Question: .....

.....

Answer: .....

.....

Check the limits set by the European standards regarding gaseous pollutants and draw your conclusions in relation to the field of study

4. With the above in mind, interview the site guards about their experiences with unpleasant odours:

A. Question:

Answer:

B. Question:

Answer:

C. Question:

Answer:

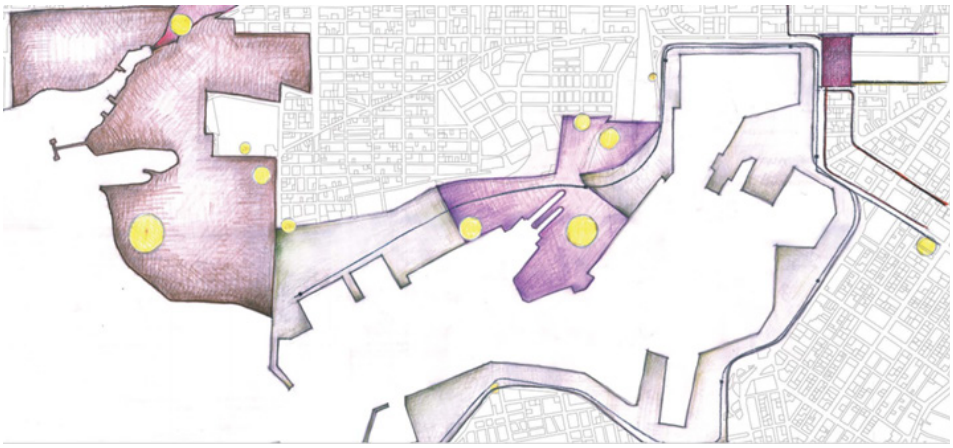
5. Complete the table below by adding the photos you have taken (you need more than one visit to the site to complete the table).

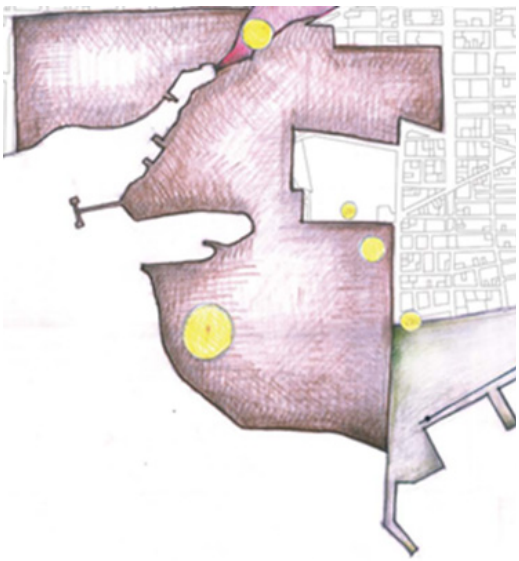
WIND DIRECTION	ODOURS (description)	LOCATION POINT	UNPLEASANT/ PLEASANT ODOUR	UNPLEASANT/ PLEASANT ODOUR
SOUTH				
NORTH				
NO WIND				

6. Make the best use of the OdourCollect app to record your odours (type, intensity, hedonistic tone, source, duration).
7. Present your conclusions to the assembly and complete your thematic map with your photos and observations (Annex 2c). Record your comments about the effects of odours on the environment and people.

ANNEX 2a

Topographical map of the former industrial site of the Drapetsona Fertilizer Factory and the wider area





ANNEX 2b

ANNEX 2c

Illustrative topographical maps from the point of view of natural scientists and from the point of view of social scientists

Source: https://akea2011.files.wordpress.com/2014/01/ionalex02.jpg

ANNEX 2d

Information on the former industrial site of the Fertilizer Factory

The former industrial site of the Fertilizer Factory is a special environmental site and social asset for the local community, because it provides, for the first time, to the citizens of the Municipality of Keratsini-Drapetsona and neighbouring municipalities access to the sea front. Since its operation was suspended, the Fertilizer Factory became the subject of claims by local residents' movements for many years, until the moment part of it was given to the Municipality of Keratsini-Drapetsona. As an open space, it became the subject of redevelopment, but much remains to be done, especially in the space that does not belong to the Municipality, but which is of great interest, among other things, in terms of preservation the industrial heritage of the area. The drafting of appropriate

regeneration proposals requires knowledge of the site, both in terms of its geomorphology and the state of biodiversity (mainly the flora of the area), but also knowledge of the existing problems (odours and air pollution) linked to recent industrial activities (ship oil processing). The issue of unpleasant odours associated with the recent industrial activity poses problems for the local community and raises controversies that active citizens are called to solve, since next to the sports and walking areas of the area that has been given for regeneration there are the boilers of the mineral oil processing units.

SCENARIO 4

THE MAGICAL WORLD OF PLANTS AS A MEANS OF PRESERVING LIFE.
IN THE SCHOOL GARDEN AND THE SCHOOLYARD WITH PL@NTNET/NATUSFERA

Christina Kalatha, Smaragda Kollia, Ioanna Dinou, Varvara Petridou

Age group:	Secondary Education (High School, Lyceum, schools for children with specific needs Intended for students across the spectrum of learning abilities (including learning disabilities) and/or with motor disabilities, but not intended for blind students
Duration:	3 months (24 teaching hours)
Tool / Platform:	Pl@ntNet/Natusfera
Field:	school garden/yard
Keywords:	climate change, microclimate, endemic plants, xerophytic conditions, noise pollution, chemical pollution, composting, urban agriculture

Citation: © Kalatha, C., Kollia, S., Dinou, I. & Petridou, V. (2023). The magical world of plants as a means of preserving life. In the school garden and the schoolyard with Pl@ntNet/Natusfera. In M. Daskolia (Ed.) *Environmental Education for Sustainability and Citizen Science. Integrating environmental citizen observatories into school educational practice* (pp. 189-209). National & Kapodistrian University of Athens Press. https://doi.org/10.26247/nkuapress.ebook.2

BRIEF DESCRIPTION

The scenario attempts to connect Citizen Science with EE through the use of the Pl@antNet/Natusfera platforms. An interdisciplinary approach, which will involve secondary school students, teachers, the local community and Local Government, EECs, Local Thematic Networks, traditional seed conservation groups and organic farmers, as well as the academic community, is planned to achieve parallel goals (environmental, scientific, citizenship, and digital literacy). The target and core activities of the scenario are as follows: promoting the school garden as a learning environment (recognising the existing plant species with the use of Pl@ntNet, entering them in a botanical list, distinguishing between endemic and non-endemic, beneficial and nonbeneficial species), becoming aware of climate change as a problem (local and global) that affects biodiversity and the individual and social responsibility for dealing with it, taking initiatives and action to create a beneficial microclimate in the school environment through the selection of plant species resistant to dry conditions, design of new planting areas, building a plant fence to absorb noise and chemical pollution and introducing composting at the school and, finally, taking action to inform and raise awareness of the school and local community (artistic works, preparation/packaging of products from the school garden, digital poster, electronic calls etc.), maintaining the garden and updating the Pl@ntNet platform with new data. The project includes activities at the home, in the neighbourhood, at the school garden/yard, in the classroom, in the computer lab, and in the library.

CONNECTION WITH CURRICULUM SUBJECTS

Biology:	plants (definition, parts, function), climate change, biodiversity
Geology:	microclimate
Language Literature:	texts & myths, creative writing
Mathematics:	counting plants, measurement of parameters (temperature, distances, etc.), calculating the size of an area
Social and Citizen Education:	democratic processes, obligations and rights, terminology (urbanisation, urban agriculture)
PC applications:	information retrieval, collaborative documents
Drawing:	garden plan
Visual arts:	art history (paintings with a plant theme), land art

Foreign Languages:	instructions and use of Citizen Science apps, international bibliography
Physical Education & Music:	traditional dances and songs about herbs and trees

LITERACIES

Environmental literacy

- understanding basic ecological concepts
- knowledge of plant ecosystems, endemic plants
- garden care experience

Scientific literacy

learning about

- Citizen Science
- the flora of the wider area of the school and its importance
- the importance of biodiversity
- climate change

Citizenship literacy

awareness

- of the interaction of environmental and political-economic problems (environmental degradation, climate crisis, breakdown of social fabric, robotic model of economic development)
- of the need to change production-consumption relations, social values and lifestyles
- of the right to a healthy environment
- of obligations/responsibilities towards the community for environmental protection
- of participation in environmental actions (tree planting, forest/beach cleaning)

Digital literacy

- use of the Pl@ntNet platform
- use of digital technology
- use of digital tools for posters/presentations

Basic literacy

- writing (poems, short stories)
- reading (literary texts, myths, historical works)
- mathematics (plant counting, statistical research)
- drawing (designing an ideal school garden)
- instrument handling (thermometer, hygrometer)
- foreign languages (to use the Citizen Science platforms)

GOALS / SKILLS

Creative thinking:	writing literary essays
	creating paintings, land art works
	processing/packaging/offering products
Critical thinking:	taking action to improve the school environment
	participation in scientific - technocratic environmental problem solving (improving the microclimate of the area by choosing suitable plants for planting)
Problem - solving:	changing the microclimate of the school area
	selecting plants for planting (water needs, useful properties)
	achieving nutritional self-sufficiency (e.g. small vegetable garden)
	active citizenship with participation in decision-making
Decision - making:	selecting plants and planting sites based on the well-being of the plants and the increase in the production of the vegetable garden
	selecting plants to be replaced by other, more useful ones
	selecting plants for shade only in summer (deciduous), with endemism in mind (for all new plants)
Learning how to learn:	knowledge development according to personal

	needs through the Pl@ntNet/ Natusfera platforms, but also authoritative internet sources based on previous knowledge and experiences
	transforming the collective knowledge of the group, becoming familiar with it and consolidating it
Searching for and analysing information:	Internet
	libraries
	Pl@ntNet/Natusfera applications
	creating a table of necessary and desirable plants for planting
	enriching the table with information on the plants' properties (water needs, endemism, flowering/ fruiting periods) and information analysis
Communication of ideas and information:	publication in the local electronic press
	posting padlets on the school's website with the areas in which the students worked, photos per task stage, relevant material which will continue to be enriched (project sustainability)
	sending an informative email with links to the parents and guardians of the students of the entire school
	publishing an electronic poster on the website of the Municipality
Flexibility of thought and adaptability:	processing information and perspectives
	exposure to questions and assumptions
	use of evidence
	calculating variables for garden design
	studying similar cases (different cultures, time periods, etc.)
	addressing the issue in its entirety
	vision, design solutions
Collaboration - teamwork:	collaboration to create new fields of knowledge through collective knowledge
	cooperative learning in teams of 3-4
	realising that the success of each team member

	depends on the success of the team itself
Leadership and responsibility:	shining a light on students with leadership skills
	taking responsibility (planting planning, garden care, reducing water consumption, reducing waste production-composting)
	students-active citizens
Developing initiatives:	acceptance of the uncertainty principle
	careful decisions
	implementation of democratic processes
	vision
Project production and consistency in execution:	task timetable
	assignment
	record of consistent implementation (date - signature)
	regular check by the teacher (in remote implementation)
Sense of personal and social responsibility:	acceptance of being part of a whole
	transmission of a value system
	transmission of respect for others and for the environment
	love and care for school: "A school with a beautiful school garden inspires us to be creative..."

LINK TO THE 17 SUSTAINABLE DEVELOPMENT GOALS

Goal#2: Zero hunger - Investigating the benefits of urban agriculture (in case of the creation of a school vegetable garden, where the products can be made available to meet the nutritional needs of the students' families or to the social grocery store)

Goal#3: Good health and well-being - Good health refers not only to physical health (through exercise and good nutrition), but also to mental health (through engagement with nature and activities implemented in it, such as digging, planting, plant care)

Goal#4: Quality Education - Associated with equitable education (of different genders, races, and students with different learning abilities), practical skills, and the ability to engage with a subject that engages different types of intelligence, enabling everyone to participate and to have fun creating

Goal#11: Sustainable cities and communities - The school garden will be a model of urban agriculture where vegetables are planted and will serve as a model for achieving the goal of food self-sufficiency

PHASES

PHASE 1: Walking - Seeing - Smelling - Recognising - Recording

(6 teaching hours / school yard/garden, classroom, library, PC lab, home)

Brief description:

Exploring the schoolyard environment. The first step consists in identifying the plant material, so hat it may be classified into categories and recorded, while at the same time investigating its usefulness. The specific planting locations will then be searched for and mapped.

Activities

1. Observation and recording

Getting to know each other - Divide the students into teams. Getting to know each other - Divide the students into teams. Ask the teams to move along a different path, to take pictures and identify the plants they come across. Activation of the senses and use of identification grids combined with the Pl@ntNet app. The flowering and fruiting seasons are identified through the platforms used. Creation of a botanical sampler. Actively involving the senses and exploiting identification keys and, above all, the Pl@ntNet application. The flowering and fruiting seasons are identified through the platforms used. Creation of a phytology.

2. Where do they belong? Are they useful to us?

The Latin and common names of the plants identified are recorded while, at the same time, an internet search is carried out on the properties of the plants, their uses, and their endemism. Were some of them not supposed to be in the school garden?

Phase 1 activities are presented as ACTIVITY 1 in the DETAILED PRESENTATION OF SELECTED ACTIVITIES below.

PHASE 2: Dreaming - Investigating - Choosing

(6 teaching hours / school yard/garden, classroom, library, PC lab, home)

Brief description

The plant material for the future plantings is selected based on the needs of the school unit, the available free space, the particular soil and climate conditions, the possibility of irrigation in the summer months, and the possibilities of acquiring plants.

Activities

1. Climate change - We adapt

Study of the climatic data of the region from the NMS database and record the current atmospheric quantities by purchasing a weather station kit and placing it in the area. Comparison of the data with the soil-climatic requirements of the existing plants. Searching for evidence of climate change impact on garden plants.

2. Selecting plants that serve the needs of a school garden

Investigating the needs of the school community and formulating proposals for new plantings of suitable plants, according to the available space and soil and climate conditions. Selection from the Pl@ntNet application of hardy endemic plants that are adapted to the xerophytic conditions of our country.

PHASE 3: I inform the school community - I roll up my sleeves...

(6 teaching hours / school yard/garden, classroom, library, PC lab, home)

Brief description

Preparing the site for future plantings. The school community is informed about the existing plant species and their usefulness. Market research is done for the acquisition of new plants and the search for the necessary materials for the construction of a composter.

Phase 2 activities are presented as ACTIVITY 2 in the DETAILED PRESENTATION OF SELECTED ACTIVITIES below.

Activities

1. Preparing the surrounding area for the new plantings

The students participate in cleaning the school garden from the various waste, weeding, carving and caring for the existing plants and trees. The new planting sites are identified. This is followed by the acquisition of plants or seeds from relevant entities (botanical gardens, nurseries, other schools' seed collections, or an offer from the Municipality). Implementation of plantings.

2. Update on composting

The students are also informed about waste management, especially organic waste, and learn about the role of and how to use a composter. Building a composter (e.g. from pallets and chicken wire) or asking for a donation for its purchase, either from the Municipality, or from the school's Parents and Guardians Association. Compost production, after first informing the rest of the school students to participate, bringing organic waste from their homes. The parents of the students can also be involved at this specific phase of the creation/renovation of the garden and the purchase of the materials (seedlings, seeds, composter, fertilizers, sprinklers, etc.), so that the whole process is accelerated.

PHASE 4: I plan - I take action - I inform

(6 teaching hours / school yard/garden, classroom, library, PC lab, home, neighbourhood)

Brief description

Division of tasks related to taking responsibility for the care of specific plants or parts of the garden, keeping a diary recording the type of activity, monitoring the growth of the plants, photographing and feeding the Pl@ntNet platform throughout the year. Students make a t-shirt, choosing and printing the plant of the school garden that inspires them, which they wear in outreaches to the school community and residents. An "open house" day is organised in the garden to share the work being done, receive feedback from and collaborate with the community (school and local).

Activities

1. Artistic creations

The students make information posters and draw invitations inspired by paintings by Greek painters for the open garden day. They also make bookmarks by drying leaves of aromatic plants and laminating them, filling bottles with oil in which they dip aromatic plants of the garden, e.g. bay leaves, rosemary, oregano. In addition, they make sachets of lavender leaves and jars of grated oregano, after drying them. The students' preparations and creations are offered to visitors who will come to the school for the open garden day. Students are encouraged to write a literary text, poem, or short story about a plant they liked or that inspired them. There is a presentation of these works at the open garden day.

2. Task log by team, Calendar of tasks / team meetings / results

3. Video recording of the sequence of tasks, as well as their results (before and after)

4. Project evaluation questionnaire

EVALUATION

evaluation of the process and of the result - evaluation of the participation in the learning process

- degree of response to the course of the task
- cooperation in teams
- acquisition of new cognitive or methodological skills
- acquisition of new knowledge
- course of implementation of the objectives
- dealing with difficulties
- response to obligations
- self-evaluation

Evaluation activities

1. Title: Formative evaluation

- evaluation of the course (between phases) - recognition of difficulties
- response to obligations (self - evaluation)
- analysis and description of actions
- acquisition of knowledge and skills
- analysis/description of acquired knowledge/skills (incomplete sentences: I found out/learned… I was informed that… I improved… I developed… I now feel more confident… I will apply…)
- reading reviews - improving malfunctions

2. Title: Final evaluation

open-ended (qualitative, descriptive assessment) and closed-ended questions:

- knowledge test
- increasing self-confidence
- personal satisfaction (script implementation, platform usage)
- enumeration of positive/negative points
- disproving expectations/fears
- support for using the platform
- participation valuation
- teamwork

Using a Likert scale (recording the degree of satisfaction):

- list of 6-10 sentences (affirmative or interrogative)
- closed-ended responses in the form of a 5-point scale (degree of agreement or satisfaction)

  (a) "I disagree", "I probably disagree", "I neither agree nor disagree", "I probably agree", "I agree" and

  (b) "Not at all satisfactory", "Slightly satisfactory", "Moderately satisfactory", "Very satisfactory", "Fully satisfactory"

Questionnaire with 10 open-ended questions

1. educational scenario evaluation
2. introduction to the subject-initial instructions
3. theoretical part
4. originality/appropriateness/clarity of activities
5. presentations/plenary discussions
6. degree of students' active involvement
7. degree of cooperation among students
8. degree of cooperation during teamwork
9. degree of cooperation between teacher(s)/students
10. actions in the field

Comments and Suggestions (What else could be done? Who else could contribute?)

DETAILED PRESENTATION OF SELECTED ACTIVITIES

ACTIVITY 1

Title / Subject:	We become a team - we divide into teams - we identify and record the plants in our school garden
Platform / Citizen Science Tool:	Pl@ntNet, Natusfera
Duration:	6 teaching hours

AIM

The formation of knowlegdeable students - future citizens, through their involvement in the cultivation and educational use of a garden, for mitigating and dealing with the consequences of climate change.

OBJECTIVES

- to identify plants with the Pl@ntNet application
- to develop interpersonal relationships between students and build a climate of mutual trust and cooperation
- to involve all students in school resource management processes, making use of their unique abilities, skills, and knowledge

- to develop life skills (skills that contribute to a successful, productive, and satisfying life), i.e. cognitive, social, emotional, practical skills and mind skills (describing, interpreting, questioning, observation)
- to get students to cooperate with the wider school community and the local community

HOW THE STUDENTS ARE INVOLVED WITH CITIZEN SCIENCE

Observing and recording plants: At a first level, a task is assigned to teams that are asked to photograph and identify the plants in the existing open space, following different paths, with the use of the Pl@ntNet app. Then, a preliminary recording is made on a planned route by the students or the teacher in charge, or on a pre-existing site plan.

Data organisation and analysis: Then, in the classroom, the students enter their data in a table, organising and analysing them.

DETAILED DESCRIPTION OF THE ACTIVITY

Games that help students get to know and trust each other

For the division into sub-teams, we use a card game. There are two identical cards for each pictured plant, with photos on one side and some information about the plant on the other. The images can be of conifers, flowering plants, aromatic plants, horticultural plants, citrus fruits, cacti - succulents (so that the team is divided into 6 sub-teams). We make sure that in each grouped category there are two types of plants, so that we can go from teams of 2 to teams of 4 people. The creation of the card game can be assigned to a group of students, who will discover and choose the plants with the help of the Pl@ntNet platform (or the corresponding mobile application) or the Natusferaplatform.

The design template was based on the educational material created by the EEC of Makrinitsa (Writing team: Eleni Kambaraki, Anargyros Maragakis, Varvara Petridou), Activity Guide, within the framework of the National Thematic Network "Herbs in our life" of the Makrinitsa EEC, p. 144.

Field trip to collect data

This is an organised route of interest, in the natural and built environment of the school yard, i.e. an environmental trail. The environmental trail can help to understand changes that occur over time. Changes can either be due to the season or be human-made.

Before leaving, a map of the trail/area will be prepared by the teachers (if

there is no map). If the trail is made in the already existing garden/ landscaped yard of the school, a plan of the site can be used or a plan can be created (after measuring with a tape) by the students. In the event that there is no free space at the school, a neighbouring grove, forest, playground with planting or even the route from the school to a characteristic point of the neighborhood (Town Hall, Gym, etc.) can be used. During the observation and study field trip, the students will take pictures of the plants with a camera or their cell phone camera.

Recording data and searching for additional information

In class, the students will transfer the photos they took to the computer. They register on the Pl@ntNet platform and upload their photos one by one, so that, with the help of the application, they can identify and record the common names and Latin names of the plants in a table, which they have already created in their folder. At the same time, through the Pl@ntNet platform, the students have the possibility to be taken to the map of the plant's spread, as well as to its flowering and fruiting curves, depending on the season/month of the year, in the northern and southern hemispheres. For more information, they can continue searching on the same platform or on the "Botanical-Educational website for flora" website.

Creating a plant sampler and playing with aromatic plants

While recording continues, a botanical inventory of dried leaves and fruits of the plants can be created, accompanied by an explanatory text. Also, we suggest a game of identifying aromatic plants (from the school garden/students' home garden) with eyes closed

WAY OF ORGANISING THE CLASSROOM

The games that aim to foster familiarisation/cooperation/trust and the card game for the splitting of the teams will be played in the classroom (a central space will need to be freed up, where there will be no chairs/desks); alternatively if the weather is fine, they can also be played in the courtyard. Ideally, 6 teams will be going on the environmental trail (4 people in each team), with the aim of covering the entire area under study, but also for the sub-teams to be able to comfortably observe the area and the plants. If the school has limited availiable space, then another path outside its premises can be used. The teams will need to be created in a room - and be kept somewhat apart, to be able to work as best as possible; ideally they could work on different computers or tablets for the plant identification process through the platforms. The first results willbe

presented to the assembly and there will be a discussion at the end of the collection and recording of the data.

THE TEACHER'S ROLE

Proactive. He /she plans everything necessary for the transition to the environmental trail, but also for the processing of the material, and procures the necessary materials for the creation of a plant sampler. It is important that he/she knows in advance what possibilities he/she has for the arrangement of the classroom for the sub-team task.

Supportive, consultative, and peacekeeping. He/she assumes the role of facilitator, but also of peacemaker, in cases of disputes, while he/she is ready to defuse tensions created.

Guidance and flexibility. He/she chooses the tasks to be allocated to the teams, depending on the abilities/skills of the students, but makes sure that the teams are self-managed. He/she is ready to reshape the processes, but also to make any change for the benefit of the teams and the task.

NECESSARY INFRASTRUCTURE / EQUIPMENT

- Computer and/or tablet (it is desirable to have at least 2 PCs or 2 tablets)
- Wired internet connection required (it's more secure)
- Projector and adequate space for the teams to work with extra folding chairs, so that the data can be presented to the assembly after being recorded, without changing the position (desks/chairs) of the teams' workspace.
- Plant sampler (1 for each sub-team or 1 for the whole team), thick/heavy books for drying plant parts and materials for gluing/supporting leaves/flowers/fruits on the pages of the plant sampler

ACCOMPANYING EDUCATIONAL MATERIAL / EDUCATIONAL MEDIA & TOOLS

- Recommended plants for the school environment, Dr Eirini Vallianatou
- School Urban Gardens: Why and how? EEC of Drapetsona & Troizina-Methana
- School vegetable gardens: I grow some of my own food. The gardens of the schools of the 3rd Athens Secondary Education Directorate
- The school garden of colours and fragrances. Collective Volume of the Local Thematic Network (Primary Education) of the 3rd Athens Secondary Educa-

tion Directorate

- EE Draft Project for the school garden
- Makrinitsa EEC material, in the context of the "Herbs in our life" NTN

DELIVERABLES

- Data logging tables
- Presentation of results either in ppt or poster format (print or electronic)
- Model of the school site with the existing plants and existing structures, signs for the plants, where the details of each plant will be written (basic information) - wooden signs or signs with a wooden base and laminated paper on them with the information material.
- Contribution by the environmental team by posting photos to Pl@ntNet

EVALUATION

- Evaluation of the cooperation of the teams among their members and between the teams through observation, but also on the basis of the deliverables (observation of the degree of participation in the process, cooperation, understanding and observance of democratic procedures).
- Evaluation of the knowledge gained through the process of plant identification by means of a questionnaire of photo-plant name matching.

NOTES - COMMENTS - INSTRUCTIONS

In this activity, it is very important to have at our disposal at least one PC or tablet per student sub-team, so that everyone can become skilled in searching for information from reliable sources on the web. In this way, the students will be more involved with Citizen Science, since they will be able to take photos in their team, upload them to the platforms, see the results from the identification of each plant and the percentage of validity of the identification of each species, depending on the quality of the photograph, the angle of taking the photo, but also the wealth of photo posts by other members of the platform and their commentary.

Since it is not allowed to move groups of students to the school computer lab (when they do not have a class), a loan of computers could be requested from a Bank, or another organisation, of the PCs and their accessories, during their renewal and the purchase of new ones. Thus, there will be the possibility of equipping at least one additional school room with computers and screens.

ACTIVITY 2

Title / Subject: Climate change - We adapt by planting the right plants in the right places...

Platform / Citizen Science Tool: Pl@ntNet, Natusfera

Duration: 6 teaching hours

AIM

Learning to design and redesign the courtyards of their schools, with the aim of sustainability and contributing to the increase of green spaces within the urban environment improving the aesthetics of part of their region/city/community, as well as the conditions of the microclimate.

OBJECTIVES

- To observe the flowering and fruiting periods of the plants and compare them to the existing data on the Citizen Science, Pl@ntNet and Natusfera platforms.
- To record questions-queries, which they will try to aswer/solve in their teams
- To make the best use of tools and instruments to measure and record meteorological variables
- To come into contact with the process of measuring meteorological variables (temperature, humidity, barometric pressure, wind characteristics, solar radiation) by the NOA (National Observatory of Athens), Meteorological Stations of the Meteo.gr Network, etc.
- To gain knowledge on plant welfare and growth conditions (climatic conditions, soil, irrigation) and optimal crops per region, given climate change
- To develop critical thinking by formulating proposals related to planting and plant location solutions, with the aim of reducing the energy consumed for heating and cooling the school building

HOW THE STUDENTS ARE INVOLVED WITH CITIZEN SCIENCE

The students observe, take measurements, record the measurements, evaluate their data, determine the acidity of the soil by themselves, using the experiment found in the material of the Drapetsona EEC "Urban gardens: why and how".

DETAILED DESCRIPTION OF THE ACTIVITY

Brainstorming

On a board, the students explore the concept of climate change in terms of their pre-existing knowledge.

Measurements of meteorological variables at school

By purchasing a weather station kit and placing it in the area, measurements are made regarding the temperature, humidity, speed and direction of the wind (in case the school is a Vocational Lyceum, the kit can be prepared with the cooperation of all technical specialties and at a lower cost, within the framework of the different courses in the curriculum).

Data search

The students ask questions, think, discuss and then look for answers on the website of the National Meteorological Service.

Data logging/sharing and further search

Students enter the data they have collected into the Pl@ntNet platform (or another platform they have chosen, e.g. Natusfera). In addition, by clicking on the Latin name of the plant on the Pl@ntNet platform, the students can check whether or not the flowering or fruiting of the plant coincides with the correct time period, according to the climatic data of the area. If an incompatibility is found, it could be an indication of climate change. At the same time, the students record the needs of the existing plants in terms of temperature, humidity (watering), the necessary soil elements for their growth and their fertilisation needs in a table.

Site redesign

In collaboration with an agronomist and/or the Department of Urban Green Spaces of the Municipality to which the school belongs, the students plan the redevelopment of the garden or the creation of a new planting area, where the team deems it most appropriate (a combination of creative and critical thinking).

WAY OF ORGANISING THE CLASSROOM

Garden or yard design and/or garden restoration, internet research, and/or literature research activities will take place in the classroom. There will

be brainstorming, discussions with experts, but also discussions between sub-teams. The classroom space will remain arranged with the sub-team workspaces, but will also have folding chairs in the centre to make it easy to follow the talks and also allow the teams to see the brainstorming board.

THE TEACHER'S ROLE

Facilitator. He/she will bring the students in contact with the expert scientists, as well as representatives of the Local Government Authority.

Supportive, consultative, and peacekeeping. He/she contributes to the distribution of the tasks to be allocated to the sub-teams, depending on the abilities/skills of the students, but makes sure that the teams are self-managed.

Flexible. He/she is ready to reshape the processes, but also to make any change for the benefit of the teams and the task.

NECESSARY INFRASTRUCTURE/EQUIPMENT

- Computer and/or tablet (it is desirable to have 2 PCs and/or 2 tablets)
- Wired internet connection required (it's more secure)
- ΠProjector and adequate space for the teams to work with extra folding chairs, so that the data can be presented to the plenary after being recorded, without changing the position of the desks and chairs of the teams' workspace.
- Weather station kit

ACCOMPANYING EDUCATIONAL MATERIAL / EDUCATIONAL MEDIA & TOOLS

- Worksheets
- Links to find climate change data - quantitative measurements (HNMS)
- Educational games (material for study by the EEC and other Entities)

SELECTED EDUCATIONAL MATERIAL FOR FURTHER STUDY

Educational Games for Climate Change - EEC of Eleftherio Kordelio & Vertiskos

- E-CO-foot - Training for the Ecological Footprint, EEC of Pertouli Trikkaia, 2020
- What is the ecological footprint of your daily activities? - EEC of Pertouli

Trikkaia 2020

- Practical guide to creating a school vegetable garden, EEC of Pertouli Trikkaia 2015
- A quick guide to creating a sustainable Mediterranean garden, Nicosia, Cyprus, 2012
- The Forest, an integrated approach, WWF Greece, 2012
- Educational Material for schools - Healthy children, healthy planet WWF Greece
- Climate crisis and Energy WWF Greece
- Movie suggestions for C.C. - Zephyrio 1st High School
- ActionAid_Climate change and poverty_book_activities

DELIVERABLES

- Temperature log tables, to compare the new data with older temperature data from the HNMS
- Students photo albums of plants and/or plant parts by season/month and plant category
- Contribution to the Citizen Science platform communities (Pl@ntNet), by uploading photos, plant details and discussion between members of each community
- Athens Water Supply and Sewerage Company (EYDAP) account registration table for comparing data on water consumption at the school (water for watering the school garden, especially if there is a lawn)

EVALUATION

- A true-false questionnaire can be used to assess knowledge about recognising and understanding the effect of climatic factors on plant growth and well-being.
- A true-false questionnaire can be used to assess knowledge about the selection of suitable plants according to endemism, but also the climatic conditions in which these plants thrive.

*In the event that the project lasts for longer than two months, the products that will be collected will utilise the objectives of urban agriculture.

NOTES - COMMENTS - INSTRUCTIONS

It is very important to have at least one computer or tablet per student group, so that everyone has the possibility to search for information on valid sources on the web. In this way, it will be easier for the students to engage with Citizen Science, since they themselves within their group will be able to take photos, upload them to the platforms, see the results of the identification of each plant on the screen and the percentage of validity of the identification of each species, depending on the quality of the photo, the angle of the photo, but also the diversity of photo posts by other platform members and their commentaries.

SCENARIO 5

BECOME AN AGENT AND TRACK DOWN THE INVADERS IN OUR RIVER - WHY DO THEY GROW WHERE THEY ARE NOT SOWN?

IN TWO URBAN STREAMS WITH PL@NTNET

Fotios Danaskos, Afroditi Katsigianni, Themistoklis Sbarounis

Age range:	High school (12-15 years old)/ possibility for people with disabilities to participate (path for citizens in the stream of Chalandri/ large part accessible with wheelchair)
Duration:	approx. 4 months (28 teaching hours)
Tool / Platform:	Pl@ntNet
Scope:	urban streams (Chalandri ravine, Pikrodafni Stream)
Keywords:	stream, urban tissue, flora identification, dominant plant species, invasive/ invading alien species, ecosystem changes, biodiversity islands

Citation: © Danaskos, F., Katsigianni, A. & Sbarounis, T. (2023). Become an agent and track down the invaders in our river - why do they grow where they are not sown? In two urban streams with Pl@ntNet. In M. Daskolia (Ed.) *Environmental Education for Sustainability and Citizen Science. Integrating environmental citizen observatories into school educational practice* (pp. 211-223). National & Kapodistrian University of Athens Press. https://doi.org/10.26247/nkuapress.ebook.2

BRIEF DESCRIPTION

The scenario addresses the issue of biodiversity, focusing on the study of invasive alien species and the risks of changes in ecosystems. It chooses to examine the case of urban streams, which it treats as "islands of biodiversity" in the urban environment. Specifically, the scenario is intended for high school students, who are invited to reflect on basic concepts related to biodiversity, to express their opinions and feelings by studying visual material (photographs), and to formulate hypotheses. The next level requires a more active involvement of the participants, who assume the role of the researcher, as they are asked to photograph the dominant plant species in the local stream (The Stream of Chalandri), to identify/recognise them through the Pl@ntNet application, to run a bibliographic research on the specific flora species, and to carry out a virtual navigation in the area through Google Earth. By making the best use of the two digital applications, Pl@ntNet and Google Earth, the scenario has the ultimate goal, beyond the recognition of the value of streams, to connect Citizen Science with EE by adopting practices that contribute to the production of knowledge and scientific research. The implementation of the scenario can be assisted by a EEC with a project on streams (EEC of Argyroupoli), where an educational excursion and a field visit (Pikrodafni stream) can take place.

CONNECTION WITH CURRICULUM SUBJECTS

Geology • Biology • Geography • ICT • History

LITERACIES

Environmental literacy

- identifying the various dimensions (ecological, social, cultural, historical) of urban streams in the context of a holistic approach to the environment
- becoming aware of the value of the city's stream as an important habitat for a variety of native flora
- recognising the need to preserve the natural character of the stream as a habitat for a variety of native flora
- using the city stream as a field of exploration, direct knowledge, exploratory and experiential learning.

Scientific literacy

- identifying the key concepts describing the term Citizen Science
- recognising the Pl@ntNet CO as a participatory digital practice within the framework of Citizen Science

Citizenship literacy

- recognising the Pl@ntNet CO as a participatory digital practice within the framework of Citizen Science
- contributing to the enrichment of data on the Pl@ntNet digital platform by uploading photographic material

Digital literacy

- participating in real-time collaborative text writing through the creation of a collaborative document in Google Drive
- creation, enrichment, editing and organisation of multimedia digital material in a shared digital table (for example, padlet, linoit) and enrichment, modification, editing of its content
- recording and communicating opinions using digital applications for expression and creation (e.g. wordart, answergarden, pixton)
- organisation and graphical representation of concepts describing the content of study terms such as Citizen Science in the form of a concept map (e.g. Cmap, bubble.us).
- using mobile and/or portable devices for taking photographs
- uploading digital photos to the Pl@ntNet digital platform

Basic literacy

- identifying key concepts related to streams and their various dimensions (hydrological, ecological, social)
- developing the ability to express oneself through written and spoken language

GOALS / SKILLS

Creative thinking:	activities 1.1, 1.5
Critical thinking:	activities:1.2, 1.6, 1.7
Learning how to learn:	activity 1.4
Searching for and analysing information:	activities: 1.2, 1.3, 1.4, 1.5, 1.6, 1.8
Communication of ideas and information:	activities:1.1, 1.2, 1.3, 1.5, 1.6, 1.7, 1.8
Flexibility of thought and adaptability:	activities 1.2, 1.7
Collaboration - teamwork:	activities 1.5, 1.10
Development of initiatives:	activities 1.5, 1.10
Project production and consistency in execution:	activities: 1.3, 1.4,1.5, 1.6, 1.7

LINK TO THE 17 SUSTAINABLE DEVELOPMENT GOALS

Goal#4: Quality education. Interdisciplinary education, targeted on topics of special interest

Goal#6: Clean Water-Sanitation. The water in the stream comes from the mountain and its sources and is potentially clean or needs to be kept clean.

Goal#11: Sustainable cities and communities. A city that has such a structure in its fabric and such a characteristic microcosm and microenvironment has special characteristics that enhance in multiple ways the city's microclimate, quality of life, and resilience.

Goal#14: Life below water. The students will identify and understands the link between life and water and especially the water flowing in the stream

Goal#15: Life on land. The life in the riverbed and the riparian area is very characteristic and of great value for (urban) biodiversity.

PHASES

PHASE 1: A stream flows in our town

(15 teaching hours/ school, home)

Brief description

The aim of this general introductory phase is to familiarise students with the topic of the study. The students are asked to recognise that maintaining the natural character of a stream is an expression of nature in the city and is associated with a variety of positive dimensions. In this phase, also through the typical examples of journalism and science, the students are introduced to the idea of practices based on citizen participation in activities and processes, such as information production and dissemination, and scientific research, respectively. By making the best use of the Google Earth digital Earth mapping application, the students are able to locate the stream route and explore the data that capture the condition and land use of the riverbed and the riparian area.

Activities

1. To stimulate and arouse interest in the topic of study

(1 teaching hours/school)

As a prompt, the teacher can use a photograph depicting an area with rich riparian vegetation. The students will then be motivated to observe and describe the landscape of the photograph and to express their feelings in relation to the represented landscape (for the recording, they can use the answergarden digital application or other web-based application), to hypothesise where the given landscape might be located, i.e. to imagine what the wider area might look like and to understand the distinction between vegetation and flora.

2. I am, I am, but what am I? If you call me by my name, I am no longer... (1 teaching hours/ school)

The students study the text: Secret Chalandri: Walking along the Polydrosos Stream and ask themselves what other adjective (besides secret) they would choose for their town. They record their ideas on a collaborative whiteboard and present them in the form of a cloud chart (https://wordart.com/).

3. The Chalandri ravine and its various ramifications (1 teaching hours/school)

The students, divided in teams, will attempt to identify in the study text the various dimensions of the stream, which form the respective study categories (for example, ecological, social/quality of life, historical, cultural, educational, etc.). The teacher will share with the students the link to a collaborative digital whiteboard, which he/she will have created and structured in the form of columns/frames (for example, relevant web applications https://el.padlet.com, http://en.linoit.com/, https://jamboard.google.com). Each column/frame can correspond to each of the various dimensions. In plenary, the students will be asked to separate and categorise the relevant information in the corresponding column/category. Alternatively, the various dimensions/concepts can be organised in a conceptual map and the individual correlations between the concepts can be visually represented (examples of related digital applications: Cmaptools, bubble.us, Mindomo).

4. Research and its transported materials (3 teaching hours/ asynchronous, home)

Each team carries out bibliographic and online research and undertakes to collect digital multimedia material (text, images, videos, audio files, and hyperlinks) with content that is relevant to each of the above-mentioned dimensions/categories of study. The research can be further enriched by collecting primary material (for example, photographs and testimonies from older family members), in order to capture the change of the area over time. Each team will upload the relevant material to the corresponding column/ category of the digital whiteboard and decide on the way to organise/present and disseminate/communicate the results.

5. Citizen input to journalism (1 teaching hours/school)

The teacher will suggest that the students study the text with the subject: Citizen journalism and participatory journalism and identify key concepts (keywords) that they consider characteristic of the topic they describe (for example, technology, democratic, two-way flow, participatory, ordinary citizens, co-creation, alternative sources, production, sharing). The proposals are edited together in a collaborative shared document (Google Drive or e-class Wiki system) in order to arrive at the most representative of the proposed concepts.

6. Citizen input to science / The case of Pl@ntNet (4 teaching hours/ school, home)

The teacher can show a short video or share a link about Citizen Science (for example, a short video with Greek subtitles on youtube: "What is Citizen Science?"), with the aim of familiarising students with the terms "Citizen Science" and "Participatory Science". The students then elaborate the presentation text of the Citizens' Observatory for Biodiversity Pl@ntNet (from the educational material for the Distance Learning Project "Citizen Science and Environmental Education for Sustainability", Module 3, p. 66). Familiarisation with the Pl@ntNet application at school and at home. Our aim is that the students understand the reason for using this application and its purpose in the implementation of the project.

7. On the water course (2 teaching hours/ school)

The students, using the Google Earth application, identify the route and the elements that determine the current state of the stream, such as:

- Length of the stream route (mountainous area from which the stream originates, areas and municipalities through which it runs, meeting points with other streams that constitute the hydrographic network of the wider area)
- Sections in which the riverbed and the riparian zone retain their natural character and are of particular ecological value as a habitat for flora and fauna.
- Sections with an unformed bed and slopes or sections which have undergone minor interventions (for example, rock fall mesh - wire boxes to support the slopes)
- Sections of heavily disturbed areas where the riverbed has undergone shrinkage and morphological alteration (e.g. conversion to a closed conduit)
- Land use of the riparian zone and potential environmental pressures (uncontrolled urbanisation, road construction, forms of potential pollution)

8. Water in the stream, plants in the stream (2 teaching hours/school)

In this step, students will be helped to understand that streams are an important island of urban biodiversity. First, the teacher will highlight the special role of water for the growth of specific native plant species. The students will share their ideas by answering the question: What kinds of plants can one find in the

stream? Then they observe the Map of the Penteli-Chalandri Ravine which is posted on the website of the Municipality of Chalandri to obtain information about the flora of the area. The related discussion can lead to highlighting the value of embodied experience, which, by combining the senses, movement, emotions, thinking, can support real and meaningful learning. In this way, the students are motivated to understand the need to visit the stream, in order to be further motivated and use the area as a field of exploration, discovery, and experiential learning. In this context, the students are encouraged to take the initiative to organise a field visit/field study in order to identify and record the species mentioned in their natural habitat, but also to investigate possible cases of shrinkage and alteration of the composition of plant species and to reflect on the possible causes.

PHASE 2: We walk and discover the Chalandri Ravine

(6 teaching hours / Chalandri ravine)

PHASE 3: Visit to the ARGYROUPOLIS ENVIRONMENTAL EDUCATION CENTER - Educational Project: "Water - the Streams"

(7 teaching hours)

Activities

An educational visit will be scheduled at the Argyroupolis EEC for the participation of the environmental group in the educational project of the Argyroupolis EEC with the title: Water - the streams. The project will end with a visit to the field used by the EEC (Pikrodafni Stream). The students will fill in the worksheets of the Argyroupolis EEC project, while the use of some mobile and/or portable devices may be allowed in order to photograph the plants they will encounter. If there is an internet connection, they will use the PlantNet platform to identify the different plants which they will categorise into native and alien (invasive) species, based on the information provided by the Pl@ntNet platform.

Phase 2 activities are presented as ACTIVITY 1 in the section DETAILED PRESENTATION OF SELECTED ACTIVITIES below.

Phase 3 activities are presented as ACTIVITY 2 in the section DETAILED PRESENTATION OF SELECTED ACTIVITIES below.

At a later time, the students can compare the results of their recording in the Pikrodafni Stream with those in the Chalandri Ravine in order to determine whether alien species (invasive species) are a common threat to biodiversity in urban streams in Attica. They can reflect on the various dimensions associated with this particular threat (https://ec.europa.eu/environment/pubs/pdf/factsheets/Invasive%20Alien%20Species/Invasive_Alien_EL.pdf). At this stage, it is also suggested to highlight the need to strengthen information, awareness and public participation in risk management.

EVALUATION

- A questionnaire will be created which the participating students, parents - residents of Chalandri, as well as citizens we will meet during the field activities and will be asked to fill out.
- The deliverables of our project, which are the students' individual projects, will be evaluated by the participants in the plenary session.

DETAILED PRESENTATION OF SELECTED ACTIVITIES

ACTIVITY 1

Title / Subject: We walk and discover the Chalandri Ravine

Platform / Citizen Science Tool: Pl@ntNet

Duration: 6 teaching hours

AIM

The aim is to have direct contact with the plant species in the ravine and to acquire knowledge about the categories of plants.

OBJECTIVES

- To get to know the ravine of Chalandri and its flora
- Contact with nature and awareness of the value of biodiversity in this part of the urban fabric, which helps Chalandri and the neighbouring municipalities "breathe"
- To acquire knowledge about the various plants that thrive in the area
- To extend the knowledge the students gained from their Biology course and their participation in this project

HOW THE STUDENTS ARE INVOLVED WITH CITIZEN SCIENCE

The students will walk along the stream bed and try to record the different species of flora they encounter. They will record the different types of plants they find on the route on worksheets or with a camera. Then, an attempt will be made to search for the different species of plants, using the Pl@ntNet platform, thus contributing as active citizens to the enhancement of the data on this platform.

DETAILED DESCRIPTION OF THE ACTIVITY

During the team meetings, the students will use the Google Earth platform to identify parts of the ravine, which they will "adopt" in a sense. Accompanied by their parents, they will visit the specific parts of the ravine and, while walking, will record the plant species they will encounter on worksheets and photographs. If feasible and allowed by the mobile networks used, they will also make simultaneous use of the Pl@ntNet platform, recording on their worksheets the points, using the Geographic Coordinates, where they have identified the specific plant species and photographing them, in order to identify the specific plants at that moment or later.

WAY OF ORGANISING THE CLASSROOM

The students will be divided into teams, so that they can visit different parts of the Chalandri stream, without being in close contact with each other, and all of them will work together as a team to present their results to the assembly.

THE TEACHER'S ROLE

Guidance: The teacher will accompany and guide the activity, providing instructions and advice, which will facilitate the implementation of the whole project.

NECESSARY INFRASTRUCTURE / EQUIPMENT

- Appropriate footwear and clothing compatible with the season in which the action will take place, as well as water and a light meal
- Mobile phone, which will help to take pictures of the ravine plants
- An internet connection is desirable, in order to be able to use web applications such as Pl@ntNet and Maps (Google Earth) at the same time

ACCOMPANYING EDUCATIONAL MATERIAL / EDUCATIONAL MEDIA & TOOLS

- Topographical - Geomorphological map of the ravine
- Related information and photographic material about the ravine, after searching the internet

DELIVERABLES

- A categorised list of plants with their common (popular) and scientific names
- A worksheet, which will include the photography, recording, identification and categorisation of recognised species by their common and scientific name

EVALUATION

Creation of a questionnaire to be filled out by participating students, parents - residents of Chalandri, as well as citizens they will meet during the specific action in the field.

ACTIVITY 2

Title / Subject: Participation in the daily educational project "WATER - THE STREAMS" of the Argyroupolis EEC

Platform / Citizen Science Tool: Pl@ntNet

Duration: 7 teaching hours

AIM

The aim is to have direct contact with the plant species in the stream and to acquire knowledge about the categories of plants, which the students will collect having the relevant knowledge they have acquired from their Biology lesson and their participation in this project.

OBJECTIVES

- To understand the importance of the multiple values of streams for human life, biodiversity and as an ecosystem.
- Putting emphasis on an ecological, holistic, and systemic approach to streams.

- To cultivate critical thinking, reflection and reconstruction of the erroneous and - very often - destructive perception that streams are water conduits.

HOW THE STUDENTS ARE INVOLVED WITH CITIZEN SCIENCE

The interface with Citizen Science will be done through the visit to the Pikrodafni Stream (3rd part of the ARGYROUPOLIS EEC project - see below). As in the activity at the Chalandri Ravine, the students will walk along the stream bed and try to record the various species of flora they encounter. Then, an attempt will be made to search for the different plant species using the Pl@ntNet Platform. The students will record the different types of plants they find en route, on worksheets or with a camera.

DETAILED DESCRIPTION OF THE ACTIVITY

The school environmental team will attend the daily educational project of the Argyroupolis EEC with the title: "Water - the streams", lasting 7 teaching hours. This is a face-to-face project, which includes teaching and activities at the Argyroupolis EEC and the ecological field of the Pikrodafni Stream. This project was developed by the first Pedagogical Group of the EEC of Argyroupoli and until today it has been reformed and updated by the teachers who make up the subsequent Pedagogical Groups of the EEC. The project of the Argyroupolis EEC consists of three parts: a) General, b) Specific and c) Field Study. A detailed description of the project and relevant educational material (worksheets, student brochures, etc.) are available on the website of the Argyroupolis EEC: http://www.kpea.gr/nero_remata.php.

WAY OF ORGANISING THE CLASSROOM

The students will be divided into small teams (4-5 students), so that they can carry out the group activities at the Argyroupolis EEC and then they can visit different parts of the stream, without coming into close contact with each other. All teams will present their results to the assembly.

THE TEACHER'S ROLE

Guide. The teacher will accompany and guide the activity, providing instructions and advice, which will facilitate the implementation of the whole project.

NECESSARY INFRASTRUCTURE / EQUIPMENT

- Appropriate footwear and clothing compatible with the season in which the action will take place, as well as water and a light meal
- Mobile phone, which will help to take pictures of the ravine plants
- An internet connection is desirable, in order to be able to use web applications such as Pl@ntNet and Maps (Google Earth) at the same time

ACCOMPANYING EDUCATIONAL MATERIAL / EDUCATIONAL MEDIA & TOOLS

All the relevant educational material for the visit to the Argyroupolis EEC (worksheets, student brochures, etc.), as well as the description of the educational project, are available on the website: http://www.kpea.gr/nero_remata.php.

DELIVERABLES

- A categorised list of plants with their common (popular) and scientific names
- A worksheet, which will include the photography, recording, identification and categorisation of recognised species by their common and scientific name

EVALUATION

An evaluation form is provided, which is filled out by the Environmental Team under the responsibility of the accompanying teachers.

SCENARIO 6

THE SMELLS OF OUR CITY AND THEIR HISTORY.
ODOUR MAPPING WITH ODOURCOLLECT

Konstantia Galanopoulou, Vasiliki Kontou, Anna Trigatzi

Age range:	Secondary Education (High School - Lyceum). It is also intended for students with disabilities and special learning difficulties unless they have a problem with their sense of smell or perception.
Duration:	4 months (26 teaching hours)
Tool / Platform:	OdourCollect
Scope:	the students' area/city (Metamorfosi/Elefsina)
Keywords:	odour pollution, environmental quality, Oral History, olfactory sense of place, digital sensory map

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BRIEF DESCRIPTION

The scenario attempts to link the Citizen Science with EE and Oral History (OH), using the International Citizens' Observatory (CO) platform OdourCollect. The scenario aims to achieve parallel goals (environmental, scientific, civic and digital literacy) through an interdisciplinary approach, in which students, teachers, the local community and local government and industry actors are involved. Some of the methods and objectives of this scenario are to highlight the problem of odour pollution in modern cities through oral testimonies, create a digital sensory map of the odours of the area by the students, enriched with the stories of its inhabitants, motivating the participants and raising their awareness. The project has been designed as a working hypothesis on the example of Metamorfosi and Elefsina and includes activities in the field (e.g., walks, interviews) and in the classroom (e.g., indexing of interviews, presentation of results).

CONNECTION WITH CURRICULUM SUBJECTS

Chemistry:	2nd grade of Lyceum - organic compounds, oil, alcohols, carboxylic acids / 2nd grade of High School - physical properties of materials / volatile organic compounds - VOC
Biology:	1st grade of Lyceum - sensory organs, senses / 1st grade of High School - the nervous system
History:	3rd grade of Lyceum - History of the Modern and Modern World / 3rd grade of High
School:	Modern and Contemporary History
Civil Education:	1st grade of Lyceum - society, state and economy: two-way relations, agricultural/industrial/post-industrial society, environmental education, active citizenship, the collective interest, respect for the rights of others, individual interest, impacts: social, economic, environmental, natural environment and man, modern development models, sustainable and sustainable development - saving natural resources, renewable energy sources, corporate social responsibility, citizen responsibility and safety, natural resources
Expression / Essay writing:	1st grade of Lyceum - spoken and written word, pre-planned oral speech, dialogue, narration, description/ 2nd grade of Lyceum - news-comment, media, article/ 3rd grade of Lyceum - ways of persuasion - arguments - evidence, human

rights - science - technology - natural environment/ Text network - Material file - Oral history and the context of the crisis

Literature: 3rd grade of High School - Roidis, The Glass Shops, Chekhov, Fat and Thin, Ritsos: Romiosini, Politis, Getting to know Monica, etc.

Philosophy: 2nd grade of Lyceum - Chapter 3 (Empiricism), Chapter 6: Evaluating the act, Chapter 9: The problem of progress

LITERACIES

Environmental literacy

- developing the sense of smell, raising awareness of the olfactory stimuli of the environment, connecting with daily activities
- the importance of smell for quality of life and measurement of environmental quality
- detecting unpleasant odors - foci of pollution / pleasant odors
- integrating environmental problems into the historical perspective

Scientific literacy

- participating in an educational project promoting Citizen Science / contribution to OdourCollect research data
- becoming familiar with the content and tools of the OH method

Citizenship literacy

- designing and finding solutions for local problems in the school and local community in collaboration with expert scientists
- claiming quality of life (clean, healthy, and sustainable environment)
- contact with older generations of fellow citizens by recording their experiences with the method of OH / strengthening intergenerational relationships

Digital literacy

- mapping the olfactory memory of the place (digital sensory map enriched with people's stories)

- using digital tools (e.g., the OdourCollect application of the International Odour Observatory) as a means of information, cooperation, advocacy and resolution regarding global environmental issues

Basic literacy

- recognising smell as a biological function and as a factor of quality of life
- becoming familiar with Local History and especially with the history of the odours of the area

GOALS / SKILLS

Critical thinking:	processing and evaluating the data resulting from interviews and the OdourCollect application of the International Odour Observatory Problem-solving searching for solutions to environmental problems identified through research
Decision-making:	formulating a vision for the area and implementing it in collaboration with institutions
Learning how to learn:	creating sources through interviews with old residents self-motivation to formulate problems, identify research questions and search for answers to questions (What was life in the city like in the past? how did it smell? what are the changes in land use and activities and how have they affected city odours?)
Searching for and analysing information:	participation in activities involved in research, collection, description, recording, classification, categorisation, evaluation of difficult concepts and issues related to odours in the city
Communication of ideas and information:	communicating within the team, with relatives and fellow citizens, with the scientific and global community (through the OdourCollect platform) to search for information, exchange ideas, and solve problems
Flexibility of thought and adaptability:	comparing past data from sources with empirical observations of the current olfactory landscape of

	the city
	detecting "cracks" and "gaps" in official records
	comparison with scientific opinions and the positions of local bodies
	drawing conclusions on the quality of the environment, odour pollution and its causes which may differ from the official/dominant view
Collaboration - teamwork:	division of labour aiming at a collective outcome
Leadership and responsibility:	taking on roles within the teams according to the students' desires, inclinations and tasks
Developing initiatives:	initiatives and action for the realisation of the vision that has been co-shaped through the study of the problems associated with odour pollution
Project production and consistency in execution:	completing field work, processing deliverables and presenting the results at an event for the school / local community
Sense of personal and social responsibility:	initiation into the concept of active citizenship with a sense of responsibility for the area with regard to odour pollution

LINK TO THE 17 SUSTAINABLE DEVELOPMENT GOALS

Goal#3: Good health and well-being. By highlighting - through OdourCollect - pollution due to odours suffered by the inhabitants of deprived areas in order to exert pressure for their resolution, an attempt is made to ensure a healthy life and promote prosperity for all.

Goal#4: Quality education. An EE/ES program that makes the best use of OH empowers the teacher who seeks inclusion, as the interest of students who remain indifferent or feel marginalised in the context of formal education in the (environmental) history of their area is activated through the interview process and the experiential contact with the narrators. Thus, by promoting the cognitive, research, linguistic, and social skills of students, as well as their creativity, OH contributes to free, equal, and quality education.

Goal#6: Clean water and sanitation. Odours are related to the quality of the city's water and sewers. The Metamorfosi Wastewater Treatment Center has contributed to the reduction of the use of Kifissos and the streams that flow into it as a sewerage network, but further treatment of wastewater is required to improve water quality and address the intense problem of odour pollution

in the area. Involving students in a Citizen Science project that makes the best use of the OdourCollect application will enhance the action of citizens and institutions in this direction. Moreover, comparing the present with the past with the method of OH and drawing conclusions about the area's quality of life over time can act as an empowerment in the search and claim of solutions regarding the availability and sustainable management of water and sanitation.

Goal#10: Reducing inequalities. An EE school project that makes the best use of OH involves students in collaborative and experiential processes of historical research, where the teacher has a supporting role and learns together with the students. The hierarchical relations and competition between teacher and students, as well as among students, are thus mitigated. At the same time, intergenerational contact is encouraged, citizens are given a voice and their social, economic, and political integration is promoted.

Goal#11: Sustainable cities and communities. The aim is to empower students to become active citizens who are validly informed through historical research about the area and seek and claim solutions using the OdourCollect ICO for a better quality of life in safe, resilient and inclusive cities.

Goal#16: Peace, justice and strong institutions. Promoting peaceful and inclusive societies for sustainable development, providing access to justice for all and building effective institutions at all levels.

Goal#17: Partnerships for the goals. Revitalising global cooperation on sustainable development. A successful sustainable development project requires partnerships between governments, the private sector, and civil society.

PHASES

PHASE 1: Odours and us: listen to your... nose!

(4 teaching hours/ classroom)

Brief Description

In this phase, the students identify, define, describe odours, identify problems, highlight odour as a special feature for describing and assessing the environment around them, and learn about Citizen Science, the COs and the OdourCollect platform.

Activities 2 & 3 of PHASE 1 are presented as ACTIVITY 1 and Activities 2 & 3 of PHASE 3 are presented as ACTIVITY 2 in the section DETAILED PRESENTATION OF SELECTED ACTIVITIES below.

Activities

1. Smell - Find - Narrate (1 teaching hours/ classroom)

Fish bowl technique

- the students are divided into two concentric circles
- the students of the inner circle, with their eyes closed, try to guess and describe the smells of objects offered to them by some of the students of the outer circle
- a student of the outer circle records the descriptions with coloured markers on a large piece of cardboard or on a board
- the students swap roles, the exercise is repeated and the cardboard/ board is filled in with different colour(s)

2. Odours and problems (2 teaching hours/ classroom)

The students

- recall odours of their city through Brainstorming
- they create a Concept Map entitled "The city's odours" (sources, emotions, effects)
- they observe images of the city related to odours (pleasant/ unpleasant), describe and evaluate them

3. The OdourCollect app (1 teaching hours/classroom)

The students

- learn about COs and browse the OdourCollect platform
- they download the OdourCollect app on their mobiles
- they study how to register an odour in the application
- they learn that smell is a measuring tool that can complement or substitute expensive measuring instruments and contribute equally to scientific research and recording to improve the environment
- they observe the world map of the platform's odours, identify the densities of the entries, and wonder about the causes

PHASE 2: Odours and our city

(6 teaching hours/ field, classroom)

Brief Description

In this phase, the students become aware of odours as environmental indicators for assessing the quality of life of their city. They identify and record odours on the OdourCollect platform, draw conclusions about the olfactory identity of the city, develop a critical perspective, and take action for their school and city by participating in a Citizen Science project.

Activities

1. I walk around and smell (2 teaching hours/ field)

The blind man and his guide

- the students go out into the field in pairs in their neighbourhood or in the school's surrounding area; one is blindfolded and the other one is leading him/her (the roles can be rotated)
- the "blind student" smells and describes the odour having in mind the features requested on the OdourCollect platform
- the "guide" records the olfactory data in the OdourCollect application - recording in the application is done by real-time geolocation
- the students jointly attempt to identify the origin/cause of the odours they record
- οσμών που καταγράφουν
- they take pictures with a digital camera

2. One more nose for the Citizens' Observatory (2 teaching hours/ classroom)

The students

- study the collaborative map they have created on the OdourCollect website, ideally projected onto the wall with a projector
- they discuss the registered olfactory episodes, their characteristics (type, intensity, hedonic tone of the odour), the duration and possible origin of the odour, and become aware of the olfactory identity of their area

- they assess the extent of environmental pollution caused by odours and draw conclusions about the quality of their environment - for this purpose it is possible to take into account relevant articles
- they also highlight the pleasant odours they have registered on their route
- they ponder the importance of recording the geolocalised and real-time olfactory experience on a world map, so that it may be analysed and used by Citizen Science and for putting pressure on the competent bodies to find solutions to the problem of odour pollution

3. Smells on paper (2 teaching hours/ classroom)

The students

- use an application to create digital maps (Storymap, Google maps, etc.)
- they create a digital sensory map of the odours of their area, where they highlight the olfactory episodes they detected and incorporate the photos they took in the field
- they launch a collaborative odour calendar for their school and the surrounding area to check the olfactory quality of their environment on a daily basis
- they decide on how to use these two tools to highlight the problems they will deem more serious by acting as school ambassadors who claim a environment free of odour pollution
- they wonder what the city's olfactory landscape was like in the past and how they can research it

PHASE 3: Us and others. The city's odours tell their own history

(10 teaching hours/ classroom, school, home, neighbourhood)

Brief Description

In this phase, the students are introduced to the concept of Local and Environmental History, as well as to the principles, methodology and techniques of Oral History (OH).

Activities

1. An oral history (2 teaching hours/classroom)

- The teacher tells the students about OH (presentation software)
- This is followed by a discussion on the importance of archives and oral testimonies, the creation of archives with interviews by ordinary people in the neighbourhood, the importance of proper archiving and preservation of records, as well as the completion of metadata, sensitive personal data and GDPR, the relationship with the narrator and his/her rights, the operation of machines, etc.

2. Asking the elderly (4 teaching hours/ house, neighbourhood, school)

- The teacher provides the students with a Concession for the interviews they will conduct

The students:

- collaboratively prepare an Interview Guide for their city and its odours
- identify their narrators among the older inhabitants of their city
- conduct short interviews - alone or in pairs - about their narrators' life in the city from the past to the modern era, focusing on odours
- The narrators co-sign with the teacher in charge the concession of the interview

3. The memory of odours on the map (3 teaching hours/ home, classroom)

The students:

- edit the audio/audiovisual files of the interview and create the accompanying archives of the interview
- select the appropriate quotes and insert them into the sensory map of odours

4. Looking for the experts (1 teaching hours/classroom)

The students

- having identified the historical course of their city's odours, reflect on the olfactory identity of the area (how much it has changed and why)

- discuss the findings of their research and seek answers to their questions from experts, whom they can also identify through the website of the International Odour Observatory (IOO)

PHASE 4: The institutions and us: Odours in the past / present /future

(6 teaching hours/ classroom, school, local community)

Brief Description

At this phase, the students formulate their requests to the competent bodies, which are disseminated to the school and wider community.

Activities

1. Talking to those responsible for the present (1 teaching hours/ local community)

The students:

- address the competent bodies
- present the entries they have made on the collaborative map of the OdourCollect Platform
- formulate their conclusions
- ask questions, discuss and express their demands on the problem of odour pollution in their city

2. Preparing for the future (4 teaching hours/ classroom)

The students prepare their presentation

- print snapshots of the collaborative map they have co-created on the OdourCollect Platform, as well as the digital odour map, photos and interview excerpts
- prepare an exhibition at the venue of the event
- create the poster of the event, prepare and send invitations, post on the school's bulletin board and on a school website / social networks, publish in the local press

3. Presentation on the past/present/future (1 teaching hours/ school, local community)

The students:

- present their environmental project, the collaborative odour map of the city created on the OdourCollect Platform and the OdourCollect Sensory Map with the embedded testimonies
- communicate the results of their research and promote their proposals in search of new synergies and solutions

EVALUATION

1. "Odours and problems" (see PHASE 1: Activity 2)

The initial evaluation takes place with the concept map. The students are expected to realise and highlight the importance of smell for the quality of the environment. In other words, their environmental and scientific literacy are evaluated.

2. "I walk around and smell" (see PHASE 2: Activity 1)

By registering olfactory episodes of their area in the OdourCollect application, the students are expected to participate as active citizens in the notification of odour pollution episodes, beyond the framework of the school curriculum, at local, national, and global level. This activity, which is a form of formative evaluation, evaluates the digital and especially the civic literacy of students, and in particular their ability to take initiative and act.

3. "Smells on paper" (see PHASE 2: Activity 3)

With the sensory map of odours, the students are expected to show their awareness in highlighting odours as a sustainable indicator on an environmental, economic, social, cultural level and their active involvement in the recording of odours. This is a formative evaluation that evaluates students' environmental, scientific, and digital literacy.

4. "The memory of odours on the map" (see PHASE 3: Activity 3)

The ability to incorporate testimonies into the sensory odour map evaluates the students' critical ability to select the appropriate excerpts from their interviews, as well as their digital literacy during their integration into the

sensory map, in order to highlight the environmental problems due to odours at local and national level via the internet (school website, municipality website, website of OH Teams, and actively involve their fellow citizens. This is a formative evaluation, which evaluates the students' scientific and citizenship literacy.

5. "Presentation on the past/present/future" (see PHASE 4: Activity 3)

The final evaluation is carried out on presentation of the project. The evaluation touches on the students' ability to communicate ideas and information, their ability to work in teams and collaborate, as well as their project production and consistency in execution.

DETAILED PRESENTATION OF SELECTED ACTIVITIES

ACTIVITY 1

Title / Subject: "Odours and problems" - "The OdourCollect application"

Platform / Citizen Science Tool: OdourCollect

Duration: 3 teaching hours

AIM

The students acquire tools for Citizen Science and become young scientists who use a specific method to approach the topic being researched, the odours of their area, their causes, effects and relationship with quality of life.

OBJECTIVES

The students are expected to:

- name odours
- distinguish them based on their characteristics
- realise the difficulty of describing them objectively
- connect phenomena with reality (e.g., a pleasant odour can be noxious, an unpleasant one may be benign)
- realise the relationship of odours with people's quality of life (standard of living, health, odours pollution - causes, effects, solutions)
- perceive odours as an environmental characteristic of a place that has a lot to tell us about the area, its society, and even its history

- become familiar with the odour-related terminology used in the OdourCollect application that they will use in Phase 2 in the field, in order to register their olfactory experiences
- learn about Citizen Science and recognise that the odour issue concerns both scientists and citizens, as well as the benefits of stakeholder cooperation

HOW THE STUDENTS ARE INVOLVED WITH CITIZEN SCIENCE

- The students recall, classify, and evaluate the odours of their city with the aim of creating a Conceptual Map. They use photographs to connect odours with episodes of pollution. They look for the origin of odours and evaluate them in terms of their effects on health, they organise the empirical data related to odours, and become aware of the importance of odours for their quality of life. They acquire knowledge, exchange views, argue, develop a critical look at the issue of odours in the city, and are empowered in the direction of scientific research.
- They then discover the OdourCollect Platform, discuss how to get involved, and organise themselves. They make initial contact with Citizen Science and COs and discuss the relationship of EE/ES with Citizen Science and the COs and their potential for action for a clean environment. They realise that, by using their sense of smell as an indicator, they can influence decisions to improve their environment and quality of life. They are motivated to participate in the reflection and action of the global community in this direction.

DETAILED DESCRIPTION OF THE ACTIVITY

The students' oldfactory sense has been heightened by the previous activity where they guessed objects by their smell (Phase 1, Activity 1).
Now, in Activity 2, they are asked to describe and evaluate smells of their area:
The students are divided into teams.
They take Worksheet 1 (WS1) and Brainstorm with a question: Record smells we encounter in the city (based on experience)
They recall and record various smells of the city in small sentences or words in WS1
In plenary, students take Worksheet 2 (WS2) and organise the smells they have recorded in a Concept
Map entitled "The odours of the city".
They characterise odours according to their sources (natural or human-made),

categorise them by their intensity, duration, quality, and impact on health and quality of life (unpleasant, noxious, etc.).
The activity covers issues such as:
• What is an odour?
• Did you know that...? (trivia about the sense of smell, connection with current events (e.g., anosmia and COVID-19) - a relevant research has been carried out by the teacher, but the knowledge / experience of the students is also requested)
• What do we perceive from an odour? The students' opinions are an occasion to provide the relevant terminology: odour threshold, type (absence of odour, flowers, food, waste, biogas, biological filter, ammonia, etc.), intensity (weak, discrete, strong), hedonic tone (unpleasant, neutral, pleasant), source (urban, industrial, food industry, agriculture, livestock, Wastewater Treatment Center, landfill, etc.), effects (harmful, neutral, beneficial), duration, diffusion.
What does odour nuisance mean? What is its cause? What are its effects on our quality of life?
Each team is then given Worksheet 3 (WS3) which includes odour-related images (different for each team) and a questionnaire. The students observe the photographs and fill in the worksheet. Then, in plenary

- The teams present their listings about the photos
- There is a discussion about the categories of pollution that exist in the environment (soil, air, and water pollution) and the connection of pollution with odours. It is pointed out that when air pollution is perceived through smell then we are talking about odour pollution (e.g., diffuse odors from landfills).
- The students discuss how odours are an indicator of environmental quality
- Solutions to the problem of odour pollution are sought and proposed.
- How can we measure odours? Is our sense of smell enough and is our nose a reliable organ?

In Activity 3 the teams under the guidance of the teacher browse the OdourCollect platform and download the application for smartphones (Android) or iPhones.

- The students see that in the application citizens register the odours they perceive in real place and time.
- They observe on the world map of the platform the entries and problems that have been recorded in different regions of the world.
- They discover how an olfactory experience (my odour) is registered on the platform.

The following questions are addressed to the plenary:

- How would we go about registering the odours we recorded on the concept map we have made on the platform?
- What can be the benefit of this action at scientific, environmental, and social level? What would we gain?

WAY OF ORGANISING THE CLASSROOM

The students:
Work on WS1 in teams.
In plenary, they create the Concept Map based on WS2.
In teams, they process WS3 and discuss it in plenary. In the teams they study the OdourCollect platform and download the application on their mobiles.
In plenary, they organise the way their olfactory experiences will be registered in the mobile / tablet OdourCollect application and discuss the benefits that will result from this action.

THE TEACHER'S ROLE

The role of the teacher is to coordinate:

- he/she organises students in teams of 4-5
- he/she guides their actions with the Worksheets
- he/she coordinates how the students will move from work in teams to plenary and the flow of the discussion

The role of the teacher is:

- to stimulate the development of the students' research mood and critical thinking
- to encourage students to actively participate in solving environmental problems due to odours
- to encourage students to contribute to the COs, and
- to motivate them to act as active citizens within Citizen Science objectives and use its tools to claim solutions to environmental problems

NECESSARY INFRASTRUCTURE / EQUIPMENT

- Cardboard, papers, markers, pin board, adhesive material (blu-tack) for the Concept Map
- Computers and tablets or mobile phones, internet access for the OdourCollect application of the International Odour Observatory.

ACCOMPANYING EDUCATIONAL MATERIAL / EDUCATIONAL MEDIA & TOOLS

- 3 Worksheets: Brainstorming (WS1), Concept Map (WS2), Environment and Odours (WS3: images for 3 teams & questionnaire)

DELIVERABLES

Conceptual Map (size 50X70) to be posted in the classroom.
The Concept Map can be designed gradually in the next phases, where the students, through the experiences and knowledge they will acquire, will add concepts related to the characteristics of the city's odours, their causes, effects and solutions.

EVALUATION

The activity will be evaluated by both the students' response to the Brainstorming and the Concept Map.

The students may not have the necessary knowledge to characterise and assess odours with regard to sources and especially polluting sources and their effects on health.

After the Brainstorming it is recommended to provide them with the appropriate sources (e.g., articles) as material for the Concept Map. As for Metamorfosi, they can study the relationship of kind, intensity, etc. of the odours coming from the Kifissos River with other characteristics (e.g., clarity/colouration of the waters), as well as with human activities. They should also be informed about the operation of the Wastewater Treatment Centre, the treatment phases, the association with odour pollution episodes, and the health risks.

With regard to Elefsina, they can study how the refineries produce oil and LPG in order to understand the daily odour pollution in the Aspropyrgos area and the episodes of odour pollution from the Elefsina refineries.

They can also be informed about odours coming from the sea, litter, sewers, the food industry, agriculture and animal husbandry, plants and gardens, etc.

The degree of consolidation of the acquired knowledge will be evaluated by the Concept Map compared to the original Brainstorming.

NOTES - COMMENTS - INSTRUCTIONS

- Brainstorming can also be carried out using ICT.
- Method A: The teams enter the words they have recorded into a wordcloud generator (https://wordart.com/, http://www.tagxedo.com/ etc.)
- Method B: Each student records the words in the app e.g. https://www.mentimeter.com/ and the wordcloud is automatically generated.

The Concept Map can also be created by utilising images:

- The images are grouped. The students are asked to give titles to the groups of images (e.g., sources, emotions, effects)
- A semi-structured Conceptual Map is then created with these categories. The images are distributed in the categories and subcategories are created which are enriched with additional images/subcategories.
- The Activity with the title "The OdourCollect Platform" may be preceded by a Polling activity using ICT (e.g. https://www.mentimeter.com/) The purpose is twofold:
- For the teacher to investigate the attitudes of the students at the specific moment, in order to plan the next steps of the educational project accordingly.
- For the students to reflect on what has gone before, discuss the issue, exchange views, and argue in favour of their positions.

ANNEX I

About Metamorfosi and Elefsina

The Kifissos River flows in Metamorfosi; it is the recipient of urban and industrial wastewater as well as - through the stream of Pyrna - the treated wastewater from the Metamorfosi Wastewater Treatment Center, which, since 1986, has served the entire Attica Basin of 4 million inhabitants, a source of daily episodes of odour pollution. Recent events include the fire in the Leventaki building (August 2020) at the boundaries of the old Industrial Area of Metamorfosi and the memories of the gaseous and odour pollution of the entire area.

The area of Elefsina has developed industrially since 1880. It reached peak industrialisation in 1950 by hosting two refineries, two cement factories, two steel mills, two shipyards (in Aspropyrgos and Elefsina), paint industries, olive

oil mills. The refineries, which are the main sources of odour pollution, and the cement industries are still operational.

Between the two cities, the landfill of the basin affects the quality of odours in the environment of both areas. In Metamorfosi, on the one hand, citizens have lost the right to a healthy and clean environment with elements of nature, while in Elefsina the citizens have gone through worse situations of air pollution and odours, against which they fought to protect their lives. These values can be passed on by older generations to new generations through intergenerational contact and interaction. Thus, the variable of time through OH has a lot to offer in any case in the approach of the olfactory landscape.

Useful Websites

- International Odour Observatory http://odourobservatory.org/
- OdourCollect app via the web https://odourcollect.eu/ for smartphones (Android) https://play.google.com/store/apps/details?id=es.nobone.manchesterwebapp for iPhones https://apps.apple.com/gb/app/odourcollect/id1457119732
- Educational MOOC on odour pollution, Citizen Science and OdourCollect https://dnoses.envirolearning.net/dashboard
- On odours https://odourobservatory.org/el/about-odours/
- Measurement of odours https://odourobservatory.org/el/measuring-odour/
- Know your rights https://odourobservatory.org/el/know-your-rights/
- Resources https://odourobservatory.org/el/resources/
- Odour regulations https://www.mdpi.com/985442
- Odour policies https://odourobservatory.org/wpcontent/uploads/sites/2/2020/11/Policy-Brief-A4-Europe-GR.pdf
- Good Practices (Greece) https://odourobservatory.org/wpcontent/uploads/sites/2/2021/01/Good-practice-4_-WWTP-Greece-.pdf
- Case Study https://odourobservatory.org/el/petroleum-refinerythessaloniki/

ANNEX II

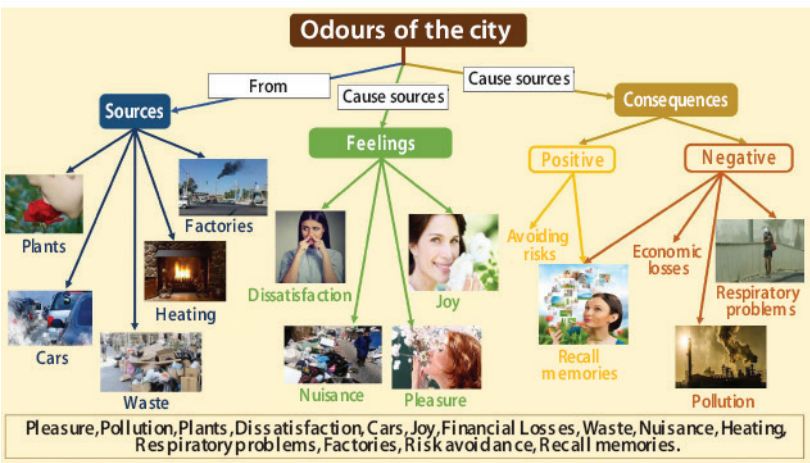
HARNESSING ICT

1. Brainstorming with Wordcloud

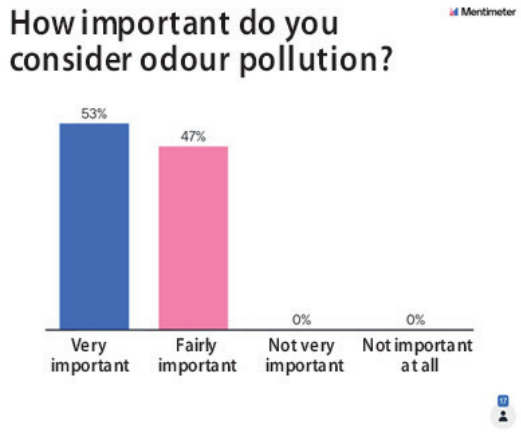
2. Concept Map with Power Point Presentation

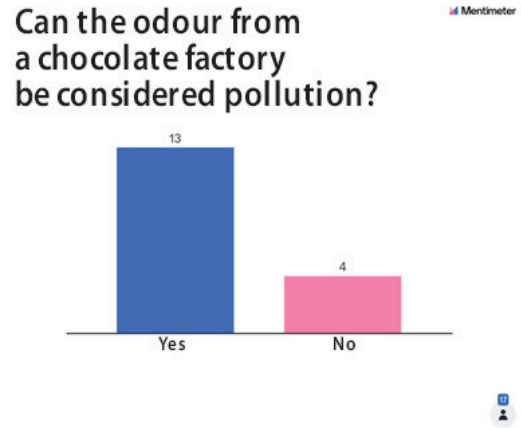

Emotions

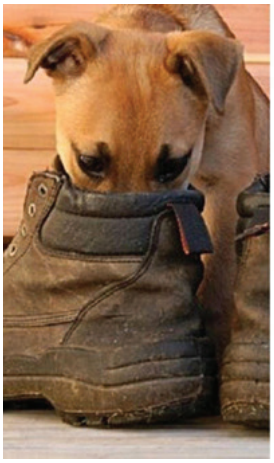

Consequences

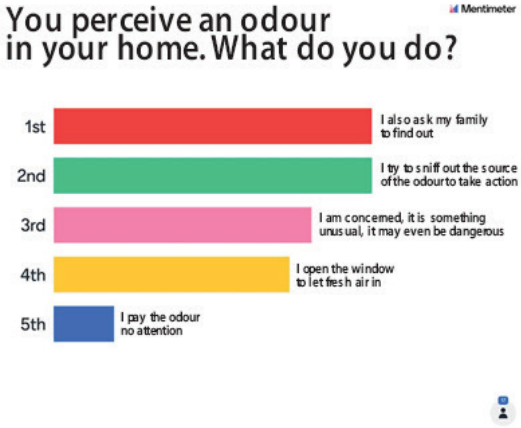

Odours of the city
From
Cause sources
Cause sources
Sources
Consequences
Feelings
Positive
Negative
Plants
Factories
Heating
Cars
Waste
Dissatisfaction
Joy
Nuisance
Pleasure
Avoiding risks
Economic losses
Respiratory problems
Recall memories
Pollution
Pleasure, Pollution, Plants, Dissatisfaction, Cars, Joy, Financial Losses, Waste, Nuisance, Heating, Respiratory problems, Factories, Risk avoidance, Recall memories.

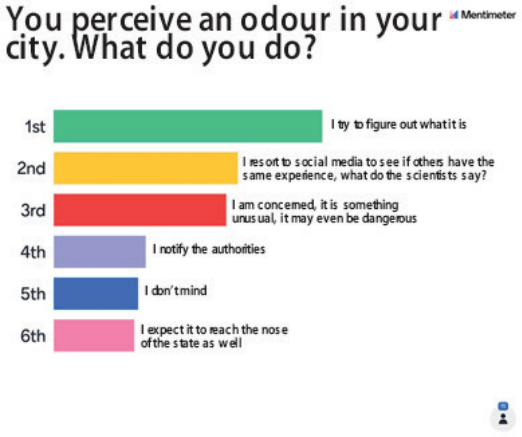
3. Opinion Poll with Mentimeter

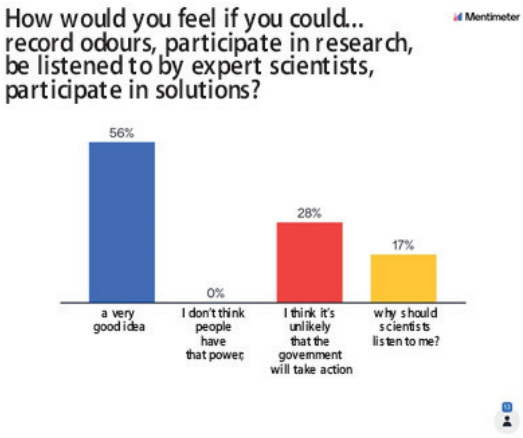









You perceive an odour in your city. What do you do?
Mentimeter
1st
I try to figure out what it is
2nd
I resort to social media to see if others have the same experience, what do the scientists say?
3rd
I am concerned, it is something unusual, it may even be dangerous
4th
I notify the authorities
5th
I don't mind
6th
I expect it to reach the nose of the state as well


How would you feel if you could... record odours, participate in research, be listened to by expert scientists, participate in solutions?
Mentimeter
56%
0%
28%
17%
a very good idea
I don't think people have that power
I think it's unlikely that the government will take action
why should scientists listen to me?

ACTIVITY 2

Title / Subject: "Asking the elderly" - "The memory of odours on the map"

Platform / Citizen Science Tool: OdourCollect

Duration: 8 teaching hours

AIM

The students acquire tools for Citizen Science and become young scientists who use a specific method to approach the object being researched, the memory of the odours of their area and the importance of the historical perspective for the sense of place and the connection with it as tools for taking responsible action.

OBJECTIVES

The students are expected to become aware of:

- the environmental history of their area with regard to odours
- the changes (upgrading/degradation) to which the olfactory landscape is subject
- memory as a criterion for quality of life
- the importance of historical research in highlighting the complex nature of environmental problems
- the search for partnerships aimed at highlighting the environmental problems of the area and claiming solutions
- the importance of OH as a means of empowerment with Citizen Science, as it enables the voice of citizens to be heard (by assessing their city environmentally with odour as an index, evaluating the quality of life in the present compared to the past, assigning responsibilities, etc.)
- the social impact of enriching the map with narratives

The students are expected to develop:

- their critical thinking, interpreting and selecting the appropriate content for the digital map
- their digital skills, integrating the narratives into the sensory odour map

HOW THE STUDENTS ARE INVOLVED WITH CITIZEN SCIENCE

Scientific logic & Decision making and policy formulation (science-driven citizen science / policy-driven citizen science)

OH is a form of Citizen Science, since it involves non-professional historians (citizens/ students) in processes (collection of testimonies from their fellow citizens, classification / processing, analysis / interpretation and dissemination) in accordance with its scientific principles and methodology. Here it seems appropriate to highlight here the key common features of EE/ES, Citizen Science and OH, in terms of their principles, methodology, and objectives in educational practice:

- transfer of interest from teaching to learning/ introduction of new ways of learning
- promoting self-directed learning and democratisation of knowledge
- participation of student/citizens in the research process, discussion and decision-making
- engaging with the local and wider community
- action-oriented and problem-based learning
- developing active and responsible citizens
- using EE/ES, Citizen Science and OH as mechanisms for strengthening and transforming science and society

DETAILED DESCRIPTION OF THE ACTIVITY

In this activity* the students:

- collaboratively prepare an Interview Guide (WS1) with questions related to the history of their city and its odours.
- identify their narrators among the older inhabitants of their city (most likely friends or acquaintances)
- take, ind or in pairs (the second student operates the machines, tape recorder and video camera), short interviews about the life of their narrators in the city from the past to the present with an emphasis on odours (preferably those registered in the OdourCollect application and with the prospect of being incorporated into the Sensory Map of Odours). After the

*This activity has been preceded by Activity 1 "An oral history" of Phase 3 where the students are given introductory training in Oral History

interview, the narrators co-sign with the teacher in charge the Concession (see Annex) of the interview.

ANNEX II

- edit the audio/audiovisual files of the interview and create the accompanying archives of the interview:
- a tab (WS2) with the narrator's profile
- a diary (WS3) with the observations and reflection of the researcher/student
- a transcript (WS4) of the interview (possibly partial)
- a summary (WS5) of the interview with the times of the thematic units
- a list/Masterlog (WS6) of team interviews
- discuss and select appropriate excerpts from the interviews
- enter the excerpts into the sensory odour map (as a transcribed text, sound or image/sound file)
- observe the mapped olfactory landscape of their area, identify the densities in space and time, and discuss how the product of their research could have a greater impact (at local and supra-local level and with the appropriate allies), in order to highlight the problem of odour pollution of the area and gain greater chances of being addressed.

WAY OF ORGANISING THE CLASSROOM

The teacher (in collaboration with the students) divides the environmental team into sub-teams of 4-5, also depending on the number of narrators.

It is recommended to create a separate team of researchers who will look for sources related to the subject under investigation before and after the interviews.

The interview process should be taken into account (preparation of an interview guide, interview & operation of machines, creation of accompanying interview records (profile card, diary, transcript, summary, completion of masterlog of interviews, selection & production of interview excerpts of written / audio / visual-acoustic and their integration into the digital sensory map of odours) when allocating roles.

THE TEACHER'S ROLE

The teacher should first act as a facilitator and then advisory/ supportive:

- He/she carries out the introductory training in the principles and methods of OH
- He/she leads the creation of sub-teams
- He/she moderates the topic selection discussion and the search for narrators
- He/she provides students with the Interview Concession
- He/she supports the students in conducting and completing their research, as well as in the process of creating the final product (stories on paper)

NECESSARY INFRASTRUCTURE/EQUIPMENT

- Tape recorder and camcorder. Alternatively, tablet or mobile phone
- Computer or laptop
- Internet connection
- External hard drive or DVD
- App for creating a digital map (Google maps, https://storymap.knightlab.com/, etc.)
- Audio and video editing software

ACCOMPANYING EDUCATIONAL MATERIAL / EDUCATIONAL MEDIA & TOOLS

- Handbook: Oral History and the Curriculum
- Interview Concession
- 6 Worksheets (WS): Interview Guide (WS1), Tab (WS2), Diary (WS3), Transcript (WS4), Summary (WS5), Interview Data Sheet/Masterlog (WS6)

DELIVERABLES

- Digital and/or printed records of interviews (audio, audio, audiovisual, transcripts)
- Interview Data Sheet (tab, diary, summary, list/masterlog of archived team interviews)
- Signed Interview Concessions
- Completion of the digital sensory map with the testimonies of the narrators about the odours of the city

EVALUATION

The following are evaluated:

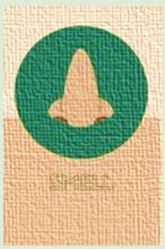
- the students' participation, cooperation, and coordination
- self-motivation and initiatives at all stages of the process
- the preparation of the sub-teams for the interview and approaching the narrators
- the interview process
- the richness and quality of research data
- the classification of interviews and the production of metadata
- the interpretive and critical ability to select the appropriate excerpts for the sensory odour map
- the technical skills for operating machines, storing digital interview files, and creating excerpts
- creativity and aesthetics in the integration of excerpts on the map

NOTES - COMMENTS - INSTRUCTIONS

It is recommended to limit the number of micro-interviews to the necessary ones (no more than five, depending on the number of sub-teams), so that they can be processed within the time limit given for the activity.

ANNEX III - WORKSHEETS

ACTIVITY 1



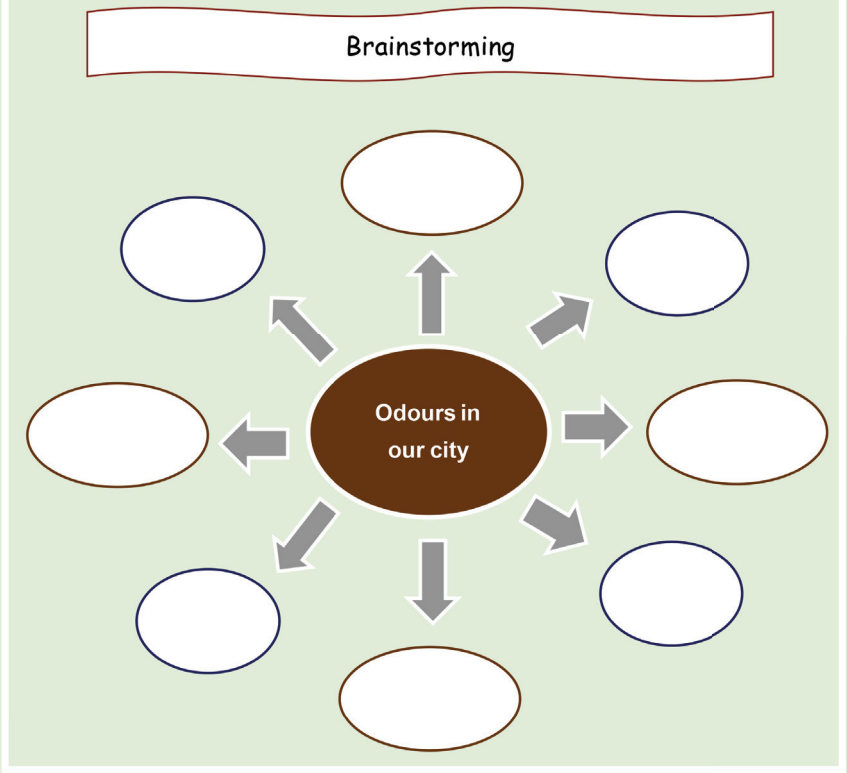
THE SMELLS OF OUR CITY AND THEIR HISTORY

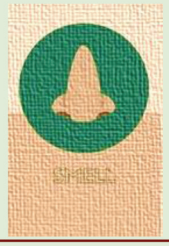
ODOUR MAPPING WITH ODOURCOLLECT

ACTIVITY 1 – "Odours and Problems"

WORKSHEET 1

Recall the smells of your daily life in the city and note words you consider related to them.



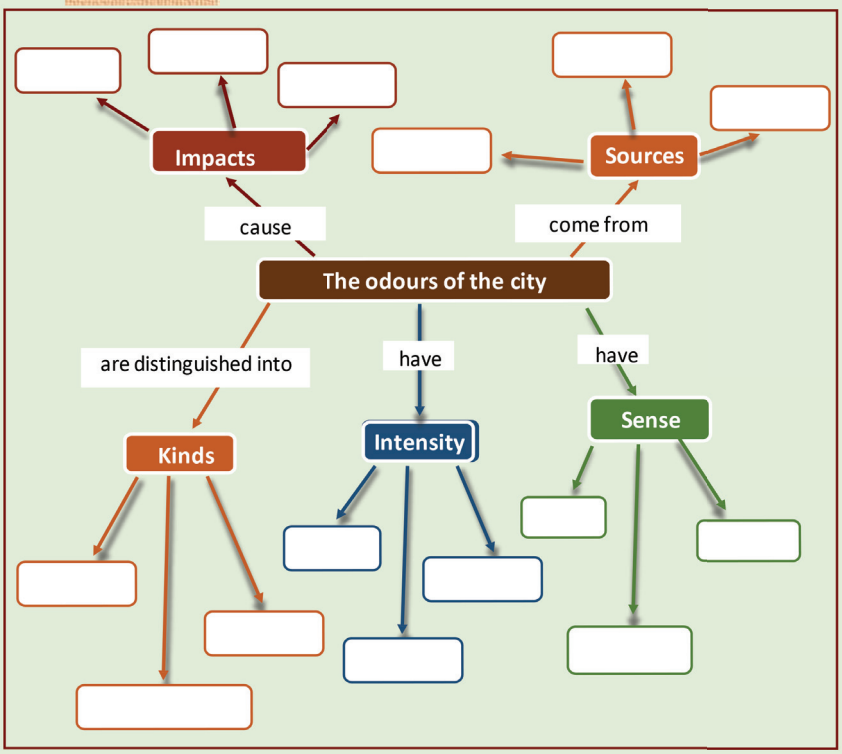


THE SMELLS OF OUR CITY AND THEIR HISTORY
ODOUR MAPPING WITH ODOURCOLLECT

ACTIVITY 1 – "Odours and problems"

WORKSHEET 2

➢ **Complete the concept map about the odours of the city.**



THE SMELLS OF MY CITY AND THEIR HISTORY
ODOUR MAPPING WITH ODOURCOLLECT

ACTIVITY 1 – "Odours and Problems"

WORKSHEET 3

- **Select one (1) of the available images.** Image ……..

1. reminds me of the smell of ……

2. makes me feel ……

3. depicts/does not depict an aspect of reality that we may encounter in our city

4. in my opinion, the responsibility for the situation presented belongs to certain persons / local government / the state

5. in my opinion, in order to improve the situation that is presented we need to ……

- **Rank each picture on a graduated scale of 1 to 5 by placing the corresponding number in a circle.**

GROUP…




IMAGE 1						
Acceptable	1	2	3	4	5	Unacceptable
Realistic	1	2	3	4	5	Unrealistic
Fair	1	2	3	4	5	Unfair
Necessary	1	2	3	4	5	Unnecessary

- **Discuss the results of your recordings.**

WS3 is based on the worksheet "Activities with pictures" by Ioannou & Photiadis in: Ioannou, Th., & Lazaridis, K. (Eds) (2014). *Good waste is waste that was never produced.* Athens: Charokopio University.

THE SMELLS OF OUR CITY & THEIR HISTORY

ODOUR MAPPING WITH ODOURCOLLECT

ACTIVITY 2 "ASKING THE ELDERLY"

INTERVIEW CONCESSION

of the … Class/ …….. Team of …

The Environmental Team of ……, wanting to contribute to the preservation of the living memory of the city, especially regarding the sense of smell, and to improve the quality of life, intends to create at the school an archive of oral testimonies with audio and video narratives concerning the history of the city's smells, as well as relevant photographic and archival material for public interest purposes. Appreciating the historical value of your testimony, we ask that you please release it to our archives by signing the following concession.

CONCESSION

I hereby provide the Environmental Team of …… with my audio/video testimony and accompanying documentation. The Environmental Team of …….. may use the material for educational and research purposes, in print and electronic publications, lectures, student conferences, student competitions, radio and television broadcasts, and museum exhibitions.

Restrictions

□ No restrictions

□ I wish to ensure my anonymity

□ I allow the use of my interview only after … years

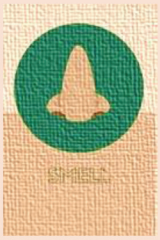
□ I do not allow my interview to be posted online

□ I do not allow access to the following parts of the interview

……

The narrator	**The teacher on behalf of the team**
Name/Address/Phone Number/Place/Date Signature	 Name/Signature

1



THE SMELLS OF OUR CITY & THEIR HISTORY

ODOUR MAPPING WITH ODOURCOLLECT

ACTIVITY 2 "ASKING THE ELDERLY"

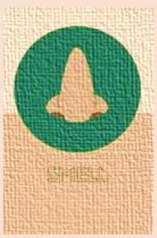
WORKSHEET 1

Before your first interview, work together to draw up a guide of key questions for your narrators based on the following indicative questions which you can formulate and/or complete.

INTERVIEW GUIDE

of the … Class/ ……..…..Team of …

- What is your name and when were you born?
- Tell us about your ancestry and your family.
- When did your family come to town?
- Have you changed residence/home in the meantime? Describe your homes and their smells.
- What was the neighbourhood/city like in the past? What smells were prevalent? How would you describe them? Were they pleasant? Unpleasant? Where were they due to? What activities were they related to? How did they make you feel?
- Do you remember any events in the city/neighbourhood that you have associated with smells? Tell us about them. What does the memory of the smell mean to you when you think about these events? What was their significance to your own life?
- Can you name any significant changes in your city/neighborhood/…….. and its activities over time? Have its smells changed accordingly? Where are these changes due to in your opinion?
- What are the characteristic smells of the city today? In which area/point have you felt them? Can you locate it on the map? (At this point you show the map of the city). Can you describe them (type, source, intensity, quality)? Which of the smells please you? Which ones disturb you? Why? How do the smells affect your life?
- How could the quality of the environment change in relation to odours in the city? What can be done to improve/solve the problem of unpleasant odours in the neighbourhood/…….?
- How could the problems caused by odour pollution in our city be highlighted? What would you be prepared to do in this direction? What would you want us to do?……..……..



THE SMELLS OF OUR CITY & THEIR HISTORY

ODOUR MAPPING WITH ODOURCOLLECT

ACTIVITY 2 "ASKING THE ELDERLY"

WORKSHEET 2

After completing your interview, fill in the narrator's details in the form below.

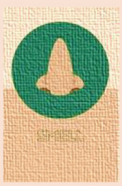
INTERVIEW DATA SHEET

of the …. Class/Environmental Team of ……..

NAME OF THE RESEARCHER:

INTERVIEW NUMBER:

INTERVIEW DATA	
Interview Date	
Interview Place	
Equipment (model)	Audio Recorder Video Recorder
Interview Duration	
Diary (yes/no)	
Summary (yes/no)	
Transcript (yes/no)	
Concession (yes/no)	
Documentation (kind/number)	
NARRATOR	
Name	
Address	
Date of birth	
Place of birth	
Education	
Biography (short)	
Profession	
Present Occupation	
Family Status	



THE SMELLS OF OUR CITY & THEIR HISTORY

ODOUR MAPPING WITH ODOURCOLLECT

ACTIVITY 2 "ASKING THE ELDERLY"

WORKSHEET 3

Compile your Interview Diary on a blank file taking into account the following questions

INTERVIEW DIARY

of the … Class/ ……..……..Team of …

Researcher:

Narrator:

Interview Date:

Interview Number:

The context of the interview:

- How did you get in touch with the informant?
- Where did the interview take place? Describe the place.
- A description of the informant (appearance, physiognomy, dress, character)
- What were his/her initial reactions?
- Was he/she willing to talk? Did he/she express a wish to remain anonymous?
- Were other people present at the interview?

The procedure of the interview:

- Describe the relationship that was established between the two of you during the interview
- Was there any change in this relationship from the beginning to the end of the interview?
- Do you feel that certain elements of your identity had a negative or positive impact on the interview?
- Were there any parts of the interview guide that the informant did not want to talk about?
- What parts was he more willing to talk about?
- On which points do you think in hindsight that you should have handled the interview differently?
- What did you personally learn from conducting this interview?

The content of the interview:

- Which topics dominate the narrator's memory?
- Which parts of the interview particularly illuminate the topic under investigation?
- What other parts of the interview seem particularly important to you?

[1]

THE SMELLS OF OUR CITY & THEIR HISTORY

ODOUR MAPPING WITH ODOURCOLLECT

ACTIVITY 2 "ASKING THE ELDERLY"

WORKSHEET 6

LIST / MASTERLOG OF THE INTERVIEWS

of the … Class/ ……..Team of …

Each new interview your team conducts should be recorded in the list below. Fill in the fields in all columns on both pages by interview serial number (SN).

	NARRATOR						RESEARCHER		ACCESS	
SN	NAME	INITIALS (eg. APAR)	DATE OF BIRTH	PLACE	GENDER	OCCUPATION	NAME	INITIALS	CONCESSION YES/NO	RESTRICTIONS
1										
2										
3										
4										
5										

	RECORDING						METADATA			
SN	DATE	DURATION	PLACE	ARCHIVE (TYPE)	Equipment	NOTES	TRANSCRIPT YES/NO	SUMMARY YES/NO	INTERVIEW DATASHEET YES/NO	DIARY YES/NO
1										
2										
3										
4										
5										
	DOCUMENTATION									
SN	OTHER (photos, documents...)									
1										
2										
3										

[1]

LIST OF CONTRIBUTORS

The Enviromental Education Lab team

Maria Daskolia is an associate professor in environmental and sustainability education at the National and Kapodistrian University of Athens, Department of Educational Studies, and head of the Environmental Educational Lab research unit. Her current research interests lie in exploring the learning potential of creative pedagogical designs and synergies in the practice of formal and non-formal environmental, sustainability and climate education, as well as in understanding and empowering students' and teachers' experiences and action based on narrative and other qualitative methodological approaches.

Dimitrios Gkotzos (PhD, MA. Med) is a primary school teacher specialized in the use of ICTs in Education for Sustainable Development. For 10 years (2012-2022) he served as Environmental Education Officer at Athens B Directorate of Primary Education. He has taught at universities in Greece and Cyprus. Since 2020, he is member of NKUA's Environmental Education Lab. His research interests focus mainly on the use of ICTs in education, climate change education and children's rights education.

Naya Grillia is a primary school teacher. She holds a Masters degree and a PhD in environmental education for sustainability. Since 2012 she is a member of the Environmental Education Lab team at NKUA. Her research interests focus mainly on teachers' narratives as tools for studying and reflecting on their identity and practice and with the aim of empowering them, as well as in the design, creation and evaluation of educational interventions and materials with a focus on environmental education for sustainability.

Zacharenia Daskalaki is a primary education teacher. She holds a Master's Degree (MEd) and is a PhD candidate at the Department of Educational Studies (NKUA). Since 2018, she is a member of the research team of the Environmental Education Lab (EEL-NKUA). Her research interests are focused on environmental education, qualitative research, and the use of digital games as educational tools to promote students' environmental learning.

Matrona Pappa is a physical education teacher in a primary school. She holds a Masters degree (MEd) and is a PhD student (Environmental Education Lab, NKUA). Since 2020 she is a member of the Environmental Education Lab team. Her research interests are mainly focused on the study of the experiential learning of primary school students in their local environments through post-humanist and new-materialist lines of thought and in the design, development and evaluation of educational interventions in environmental education for sustainability.

Maria Pliota is a French teacher in public schools and holds a Master's degree in Education

for Sustainability (Msc) and a Master's degree in Studies in Education (Med). Since 2012 she has been a member of the Environmental Education Lab team of NKUA. Her research interests focus on the design, development and evaluation of learning designs and curricula on sustainability issues for children and adults in formal and non formal contexts, educational research and consulting.

Anna Trigatzi is a Greek language and literature teacher in secondary education. She holds a Master's degree (MA) in Critical Theory from the University of Nottingham and is a PhD candidate at the Department of Educational Studies of NKUA in the field of environmental education for sustainability. Since 2021, she is a member of the team of the Environmental Education Laboratory (EEL/NKUA), where she has been involved in the design, development and evaluation of educational interventions and materials. Her research interests focus on the integration of environmental oral history in environmental education for sustainability.

Teachers - Designers of the educational scenarios

Theologia Avdelli is a primary school teacher. She holds an MSc in Environmental and Development Education and a Master's degree (MA) in Educational Organization and Management. Since 2016, she is a member of the Educational Centre for the Environment and Sustainability in Drapetsona. Her research interests mainly focus on transforming schools in learning organisations and teachers' professional development through learning communities.

Fotios Danaskos is a secondary education teacher, geologist and physiotherapist, with a Master's Degree (MSc) in Education and Social Discrimination and in Special Education. Since 2018 he is a member of the Organizational and Scientific Committee of the C.R.L.School (Corinth Rift Laboratory), the E.G.U. From 2022 he is the Geoscience Education Field Officer of E.G.U. for Greece and the General Secretary of the Teaching Committee of the Geological Society of Greece. Among his interests is the creation of educational material for teaching Geosciences in primary and secondary Education.

Ioanna Dinou studied French Literature at the University of Athens and received a Master's degree in the teaching of French as a second foreign language from Artois Arras University in France. She is specialized in the Organization and Administration of Education (Harokopeio University), in Psychology, Counselling and Sociology for All (University of the Aegean). She worked as a French teacher until 2010. She held the position of Environmental Education Coordinator from 2010 until August 2022, when she retired to work for the civil society.

Aikaterini Drosou is a primary school teacher. She holds a Masters degree in teaching Greek as a second & foreign Language. In school she tries to follow a curriculum aimed at empowering students to become responsible, environmentally aware, active citizens of tomorrow.

Ioanna Fokou is a primary school teacher. She works in Drapetsona Educational Centre for the Environment and Sustainability. She holds two masters degrees and is a PhD candidate in Folklore Studies in Education. She speaks three languages: English, Spanish and Italian, and she is learning Portuguese. She is a folktale scholar and a storyteller. She is the author of children's book. She has participated in eight collective books for children and one with environmental content.

Konstantia Galanopoulou is an architect with a specialization (MSc) in the Environmental Design of Cities and Buildings. Since 2001 she has been a teacher in secondary vocational

education. In 2012-2022 she served at the Elefsina Environmental Education Center where she participated in the design and implementation of environmental education programs for students and in teacher seminars in education for sustainability. She is particularly interested in the protection of the landscape as well as the promotion of architectural, industrial and cultural heritage as part of sustainable environmental management.

Christos Godevas is a primary education teacher. He holds of a postgraduate diploma in Education. He has been member of Teachers 4 Europe. Hea has crried out simulations of the European Parliament in the framework of the EUROSTARTS Programme Jean Monnet Action KA1/Learning EU at Schools! He has implemented projects in environmental education, health education and cultural projects. He believes in experiential learning and in the creation of active citizens within a school open to life.

Afroditi Katsigianni is a physical education teacher in primary education. She holds a postgraduate degree in Environmental Education and in Physical Activity and Well-Being with a focus on Creative Learning. Since 2008 she has been working at the Argyroupolis Centre of Education for the Environment and Sustainability. Her interests are mainly related to the theory and methodology of education for environment and sustainability, educational innovations and teachers' professional development.

Smaragda Kollia is an agronomist and a secondary school teacher specialized in Biotechnology (PhD). Since 2017-2018, she has been appointed director of the 7th High School of Piraeus. She has been involved in the planning and development of several environmental programs with the aim of raising students' awareness on issues of environmental protection.

Christina Kalatha is a mathematician with a specialization in Mathematics Education (MEd). For the last 10 years, she has been involved in environmental education/sustainability education and implemented several school programs. Her interests are in reaching out to her students, inspiring them, challenging them, and making them adopt positive attitudes for protecting the world they live in.

Vasiliki Kontou is a forester and environmental scientist and a secondary education teacher. She holds two Master's degrees in Ecology and Environmental Management. Since 2017, she is Head of the Environment and Sustainability Educational Center of Elefsina. Her scientific and educational interests focus on the pedagogical use of issues related to the sustainable management of natural and urban environment. She is an author of several books and articles on environmental education for sustainability.

Irini Michailidou is an agronomist working as a secondary education teacher. Since 2005 she is a member of the team of educators of the Education Center for the Environment and Sustainability in Lavrio. She has designed and carried out several environmental education programs focusing on organic agriculture, a subject she had also dealt with as an agronomist. As part of her work in the Education Center for the Environment and Sustainability in Lavrio, she participated in the design and implementation of environmental education programs, in the creation of educational materials and in the organization and implementation of training seminars and workshops for teachers and the local community

Varvara Petridou is a teacher on mechanical engineering and geology. She holds an MSc degree on Oceanography. She has served for 32 years in public secondary education and for the last 11 years she is Environmental Education Coordinator of the 2nd Directorate of Secondary Education of Athens. She is an educator of the Institute of Educational Policy. From January 2023, she is a member of the Environmental Education Lab of NKUA.

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Themistoklis Sbarounis is a biologist and ecologist (MSc) with 20 years of experience in environmental education. Nature conservation has been his lifelong dream since the beginning of his studies and career. After a five-year service in environmental NGOs as an ecologist and field researcher, he joined education, as this is the most holistic and effective approach to protect nature in the long term. Since 2006, he has been serving at the Argyroupolis Center for Environmental Education. Since 2011 he has been a member of the Steering Committee of the Panhellenic Association of Environmental Education Teachers and in 2019, he was elected to the central Board as Vice-President.

Varvara Vorylla (B.A. with distinction, M.Ed., Ph.D.c in life skills) has a 25 years of teaching experience. She is the Coordinator of Environmental Education in the Primary Education Directorate of East Attica. She also works with the Institute of Educational Policy of the Ministry of Education as a teacher trainer. She is a member of the Board of Directors of the Hellenic Society for the Protection of Nature and the Greek Eco-Schools Committee. Her interests lie in education for sustainable development, active citizenship and life skills.