



DELIVERABLE

D2.3 Policy Landscape Review

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Executive Summary

Nowadays, policymakers need more data to deal with environmental problems than they are able or afford to gather on their own. The high costs of the official monitoring stations, both in terms of purchasing and maintenance, and the recent advances in mobile sensors and software applications, have spun off an increased interest in setting up citizen-based sensing networks that complement the current air quality networks.

Despite the potential of citizen science to contribute to the policy processes, public authorities usually do not harness the potential of CS results to a degree sufficient for being a basis for decision making or strengthening the engagement and awareness of citizens towards the local environment.

The **COMPAIR** pilots will investigate the local policy landscape to assess the existing and potential demand for citizen science (CS) data by public authorities. In some instances, stakeholders may require citizen science to meet their data collection targets or monitor large geographical areas with high frequency. There may also be local authorities that are in the process of development and adoption of new environmental plans but lacking insights into the respective urban air quality situation. Other institutions may simply want to reduce costs by complementing centralised data collection, validation, and verification with citizen science datasets. In all of these instances, citizen science can greatly support policy actors' monitoring, regulatory and administrative efforts.

The task about framework design focuses on identifying relevant local/regional policy measures (policies, Air quality (AQ) action plans, Sustainable Energy and Climate Action Plan strategies for sustainable urban mobility, processes etc.) that can be enriched using citizens' knowledge and new data inflows.

The findings in this deliverable will be used as a base for the preparation of the D7.3 Citizen Science and its Potential to Policy Ready Data, which will describe the potential use of CS data for policy making. Including findings, experiences and advice to be used when integrating different types of CS data in the policy data creation and policy-making process.

1. Introduction

1.1 Introduction

Work Package 2 (Stakeholder Engagement & Framework Design) of the **COMPAIR** project aims to improve stakeholder engagement through ensuring the framework design takes the current landscape into account.

This report (Deliverable 2.3) presents the Policy Landscape Review and is complementary to the Citizen Science Landscape Review (Deliverable 2.2) where the Citizen Science landscape focussed on examining 100 citizen science projects, this landscape focuses on the policy context.

How do citizen science initiatives focussed on air quality measurement contribute to Sustainable Urban Mobility Plans (SUMP) and Environment Plans and vice versa? How can **COMPAIR** concretely strengthen the recognition of the value of citizen science approaches in the labs in the four pilot locations of Athens (Greece), Berlin (Germany), Flanders (Belgium) and Sofia/Plovdiv (Bulgaria)?

The goal of deliverable D2.3 Policy Landscape Review is to identify all relevant public measures (strategies, plans, policies etc.) in each pilot location (Athens, Berlin, Flanders, and Sofia/Plovdiv) that can be enriched by citizen science (CS)/**COMPAIR** results. This “policy landscape” deliverable aims to get better insights into programs, strategies, plans and policies that have been developed in a country and are related to CS. The strategic documents related to air quality and sustainable transport will be analysed to find how CS/**COMPAIR** results could influence them and how the local policies for air quality and sustainable transport could be improved with the help of CS.

In the previous deliverables, the stakeholders (D2.1 Value Network Canvas) and CS initiatives (D2.2 Citizen Science Landscape Review) in each pilot were mapped. The D2.1 Value Network Canvas provided a starting point in understanding the links among actors with shared interests in policy preparation and implementation. The results were the basis for the D2.2 Citizen Science Landscape Review. The Citizen Science Landscape Review identified past and ongoing CS initiatives in all pilot locations.

1.2 Objective

A three-tier objective set has been formulated. Each objective allows us to clarify the research basis for the next objective.

1.2.1. Academic Level:

Provide a high-level understanding of the primary effective and potential linkages between citizen science and public policy. Highlight the recognized drivers and barriers in order to provide a better background for reviewing policy documentation and the situation in pilot areas. Creating a list of academically basis for recommendations to enrich following deliverables and the impact of the CompAir project.

1.2.2. EU and Member State Level:

Create a reference table of current EU and Member State policy documentation that guides or supports the use of citizen science in public policy relevant to the areas of SUMP and Environmental Plans. This overview will strengthen the knowledge of current policy and hence form a basis to increase the alignment between European and Member State levels towards regional/local initiatives as well as the identification of missed opportunities.

1.2.3. Local/ Regional Pilot Level:

List and analyse the policy documents at local/regional level in order to identify the level of maturity and recommend next steps to strengthen and speed up uptake taking into account the current policy at pilot and EU level (Objective 2) as well as the drivers and barriers according to academic research (Objective 1).

1.3 Conceptual Clarifications

When reviewing the citizen science policy landscape in the area of SUMP and Environmental planning, a few conceptual clarifications are necessary.

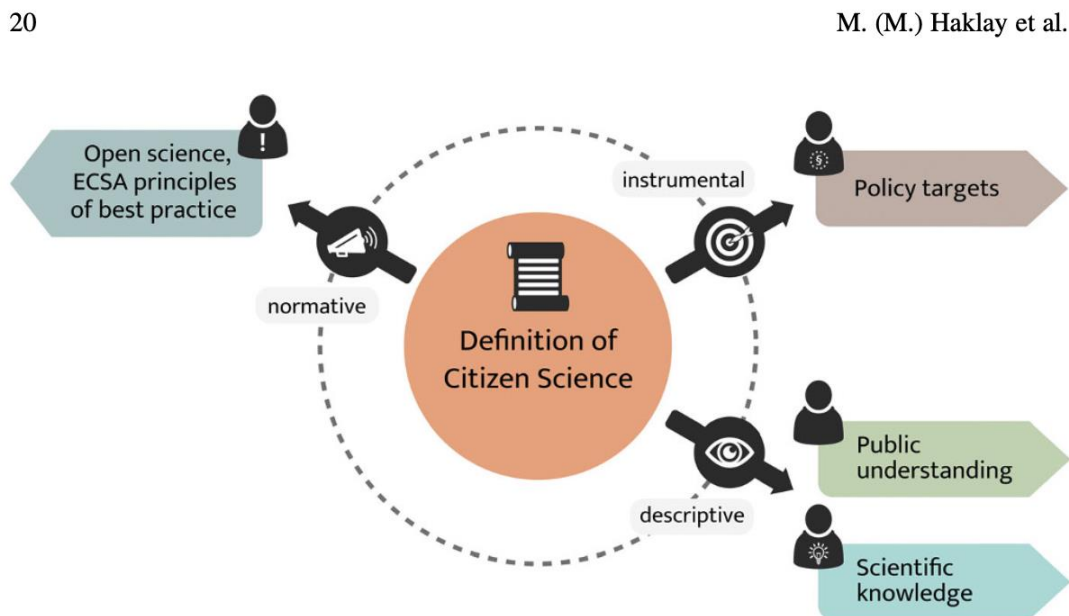
Recognizing the academic debate in defining several of the following terms. We opted for a 'fit for purpose' approach favouring the definitions found in EU Commission publications and linking to the objectives.

1.3.1 Citizen Science

The European Commission has used the definition from the Oxford English Dictionary, defining citizen science as *'scientific work undertaken by members of the general public, often in collaboration with or under the direction of professional scientists and scientific institutions. It also notes that 'Citizen Science is often linked with outreach activities, science education or various forms of public engagement with science'*. (European Commission, 2016, #)

After reviewing a selection of definitions (Haklay, n.d.) highlights their instrumental, descriptive and normative aspects in the figure below. Citizen science is identified as an instrumental aspect towards policy targets.

Figure 1 Dimension of the definition



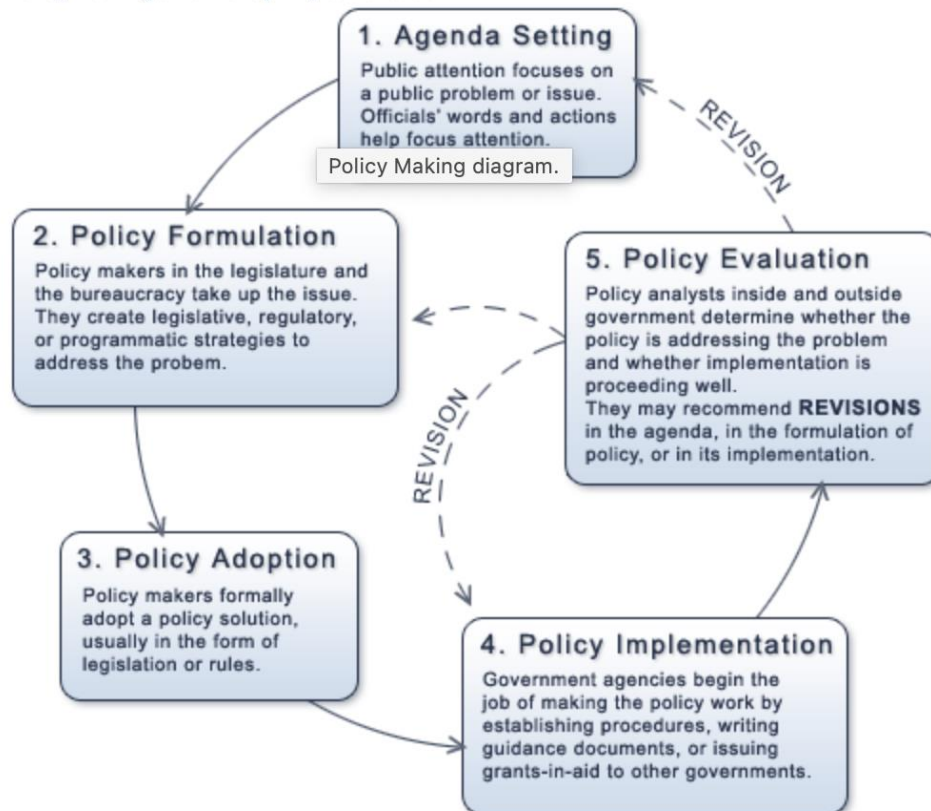
1.3.2. Policy

The Cambridge dictionary defines a policy as: “a set of ideas or a plan of what to do in particular situations that has been agreed to officially by a group of people, a business organisation, a government, or a political party.” In the context of citizen science a narrowing of the concept to “public policy” also relating to the instrumental target aspect may be advisable. Public policy “*can be generally defined as a system of laws, regulatory measures, courses of action, and funding priorities concerning a given topic promulgated by a governmental entity or its representatives*”. (Kilpatrick, 2000)

The “public policy” is the result of the “policy making and implementation process” below.

Figure 2 Policy making and implementation process

Policy Making and Policy Implementation



(Texas Politics - The Policy Making Process, n.d.)

1.3.3. Sustainable Urban Mobility Plan

A Sustainable Urban Mobility Plan (Sump) is a “strategic plan designed to satisfy the mobility needs of people and businesses in cities and their surroundings for a better quality of life. It builds on existing planning practices and takes due consideration of integration, participation and evaluation principles” (Sustainable Urban Mobility Plans (SUMPs) and Cycling, n.d.)

1.3.4. Environmental Policy and Planning

Environmental policy includes “any measures by a government or corporation or other public or private organisation regarding the effects of human activities on the environment, particularly those measures that are designed to prevent or reduce harmful effects of human activities on ecosystems.” (van Bueren, 2019)

The planning lays out when, by whom and how each measure will be taken up and delivers on the operational realisation of the environmental policy.

2. Methodology

The analysis starts with a short academic literature-based introduction, linking citizen science to policy making and possible drivers, benefits, barriers, and challenges.

The next step is a review of documents at the European level, which aims to show what is the attitude of the European Commission towards citizen science, and what is the vision for its future development and inclusion in European policies.

The policy landscape review covers the policy cascade from the European level, to the national level to the local level in each of the pilots. In addition, it covers 2 thematic dimensions: air quality and mobility.

The policy landscape review on the European level contains a review of the reports and guidelines of the EC and European Environmental Agency (EEA) as well as the most relevant citizen science-related policy documents (reports, plans, strategies, white and green papers, etc.).

The policy landscape review for each pilot (Belgium, Bulgaria, Germany, and Greece) is divided into two parts. The first part is dedicated to the most relevant citizen science-related policy documents (at the national/regional and/or local level) where CS is part of a certain specific strategy. The second one is a dedicated analysis of the strategic documents related to air quality, sustainable transport and how they relate to CS:

1. Does it cover the 10 principles of CS? of the European Citizens Science Association (ESCA)¹

2. Does it cover co-creation/co-design?

Co-creation is collaborating with all stakeholders to guide the policy design process. Participants with different roles align and offer diverse insights. Policymakers can therefore get more holistic views of what a policy could include. Co-design is the act of creating with stakeholders specifically within the design development process of the policies to ensure the results meet their needs and are acceptable.

3. Does it cover people's involvement?

This applies to people's (individuals or organised communities) involvement in public decision making.

4. Are citizens involved in data collection?

5. Is there any evaluation foreseen with involved citizens/businesses?

¹ [Ten principles of citizen science, ESCA](#)

The review of the documents in the pilot areas aim to show what the attitude is of national and local authorities towards citizen science and whether it follows the European one.

Engaging citizens in policy-making allows governments to obtain new ideas and exchange information during the decision-making process. Citizen involvement leads to a more likely chance of implementing a decision or policy and helps build accountability and responsibility for both public officials and citizens.

3. Academic Basis of the Citizen Science Policy Landscape

Citizen science and public policy share a common objective of societal impact. Citizen science realises this through research activities conducted with citizens. Public policy realises this through policy actions and regulations. How do both themes link? Which intersection points are interesting to take into consideration? What are the factors that strengthen or weaken these connections?

In 2013, a study by the University of the West of England, Bristol stated the potential value of citizen science for policy-making, “remains largely untapped” (Science Communication Unit (SCU), 2013). In 2018, 5 years later, 503 citizen science projects revealed contributions to policy (European Commission, 2018). In 2023 CompAir recognised a rich political landscape with many opportunities.

The linkages between public policy and citizen science are complex and can be viewed in various directions from bottom-up to top-down, from citizen science to public policy and vice-versa. It can also be divided according to the policy cycle phases.

Citizen science appears to some as addressing regulatory gaps and mismatches through voluntary actions of practitioners (Guerrini et al., 2018) in benefit of improved public policy. This perceived “bottom up” approach is being increasingly embraced from a “top down” perspective by government agencies as unprecedented challenges are requiring policymakers to find new ways of collaborating (Bonn et al., 2018).

Citizen science offers the possibility to citizens to be involved in environmental decision-making along two main pathways: indirectly through input or directly via public participation (Suškevičs, 2017, p.2). The public participation support can involve any of the stages of the policy cycle: problem definition, policy formulation, adoption, implementation, monitoring and evaluation. The impact and approach are dependent on the citizen science policy dimensions: How localised is the issue (geographical)? What is the policy domain (thematic)? What level of engagement is desired? This last dimension can vary from passive sensing, volunteer computing, volunteer thinking, environmental & ecological observation, participatory sensing to civic community sensing (Haklay, n.d.).

On the other hand, policy also facilitates citizen science through signal openness (and time for) a particular kind of activity, establishing clarity in precedents and laws in such initiatives

(ip, liability for volunteers, data sharing, legislative and regulatory impact) (Cavalier & Kennedy, 2016, p.355-356), shaping research agendas, mobilising resources and facilitating socio-technical co-evolution (Suškevičs, 2017, p.3). As well as indirectly through educational policy (STEM), scientific policy, culture and museums, public broadcasts (Haklay, n.d) and legislation.

The DITOs project states citizen science engages with political processes via four governance modes: (1) Source of information for policy-making, (2) object of research policy, (3) policy instrument, and (4) socio-technical governance (Göbel et al., 2019). Socio-technical governance creates possibilities in the political realm through use of technology (physical objects and technical protocols such as self-management of environmental resources without involving political representatives or established policy channels (Göbel et al., 2019).

This last mode is disruptive to the current assumptions, in which public policy is centred around politicians and formal political institutions, science and politics are separate spheres and policy making is seen as a linear process where policy makers determine rules that citizen science feeds into (Göbel et al., 2019). This is leading to an institutional struggle in which researchers question the validity and value of citizen science, standards are needed for data integration, concerns rise on the rapid pace and the ability of the process to follow and the representativeness of citizen science is questioned leading to requests towards more inclusivity towards marginalised people (Cohen et al., 2021).

Table 1 Drivers and Benefits table

POLITICAL
National strategies (Germany & UK) to enhance capacity for CS
Citizen engagement emphasised as part of good governance
Improved science-society-policy interaction
More democratic research
Use of CS by other organisations
Robust quality assurance standards facilitate uptake
Increased awareness and use of cs for scientific and societal challenges
Public participation considered necessary for the acceptance of policy and to maintain the political democratic system
Open science and Open innovation research agendas
CS community tailored communication towards policymakers
Support of CS by global associations, national organisations and capacity programmes and is promoted by CS associations

Improved policy decision-making processes
Better implementation of policy
Political literacy: Knowledge about policy issues
Societal relevance of policy
Interest in policy decision-making as well as the acceptance of policy measures
Policy makers may consult with the public and consider public contributions
Augment the creation of an evidence-base to support regulatory implementation and compliance
ECONOMIC
CS as cost-efficient way to collect evidence, monitor environmental statuses, respond to crises and provide data for management actions
Difficulties is collecting data by alternative means
Potential contribution to more efficient use of expert resources
Increasingly economic value attributed to CS data
SOCIAL
Rapid growth in higher education in the 20th century
Increased leisure time
Growth in educated and able retirees
Value of collected data and appreciation of citizen involvement is acknowledged in society
Capabilities of volunteers
Volunteer engagement supported by trust, informal networks and democratisation
Volunteering opening active citizenship
Majority of citizens would like to become more involved in political processes
“Fun, educational, engaging” nature of CS projects
Sources of motivation for participants and engaged communities
Increased understanding of science, scientific principles and scientific challenges
Individual learning and topical knowledge
Interest in a scientific career

The human eye and brain allow volunteers to categorise millions of objects or find solutions to complex problems that computer algorithms may not be able to solve.
Raising public awareness for scientific issues and research
Tapping into skills, dedication and ingenuity of citizens
Citizens learn to think scientifically and develop critical abilities
Educational benefits could be experiences in formal education as in informal learning
Growing interest in scientific career
Better understanding of the benefits stemming from the use of CS
CS support of the growing phenomena of social innovation
TECHNOLOGY
Growth of the web
Growth of mobile communication
Ubiquitous connectivity
Emergence of Web 2.0 systems
Evolution of peer-production systems in the past 10 years
Development and proliferation of cheap sensors
Lack of existing data
Combinations with new technological solutions (AI) to improve efficacy and accuracy of results
Mobiles allowing recording and mediation of real-time accurate gps data
Websites providing info on CS and links to relevant sources
Social media alongside new technologies as drivers for networking, communication or marketing
Gamification as an approach of CS
Possibilities of data collection by volunteers over a larger spatial extent and temporal scale reaching a wider geographic coverage
Improve data quality: to gain more timely information or to cover a specific topic more deeply
ENVIRONMENT

Practitioners interested in using citizen science
Scientific information, public access and use of environmental information as a prerequisite to meaningful participation
Growing attention to the concept of Responsible Research and Innovation (RRI)
Local environmental threats that require large data sets
Validation of data
Support of environmental stewardship and activism (civic empowerment)
Production of new scientific knowledge
Highlighting impact of environment change
LEGAL
Legal sources for participation in policy (Aarhus Convention of 1998 provides EU citizens the right to participate in environmental decision making)
Directives and regulations (input CS recordings EU statistics)
Signatories to Conventions that must report regularly

Table 2 Barriers and Challenges Table

POLITICAL
Implementation CS projects in Eastern Europe is challenging due to their socio-political transition histories, low social capital and relatively short traditions of civic participation
Conflicting viewpoints and practices may hinder the fruitful cooperation between volunteers and decision-makers (“free lunch for the state”)
Use and impact of CS and crowdsourcing may be constrained by institutional, legal, policy and regulatory barriers
Data quality and privacy as perceived risks to incorporating citizen science into government-led scientific research, management or policymaking
Policy makers are likely to lack the requisite knowledge of the characteristics, practical needs, benefits and challenges of CS approaches as well as the contacts to develop them
Tensions due to clashers between different governance modes
Organisational and governance issues
Difficulties of the uptake of citizen science results into actual policy implementation due

to a lack of citizen science alignment with current policy structures and agendas
Documents largely fail to address the benefits and challenges of citizen science as a tool for policy development, i.e., citizen science is mainly perceived as only a science tool
The policy community may have differences in the motivations, expectations and specifications towards the outcomes and the process of CS
Recognition of CS by science and policy
Evaluation of CS projects
Uptake of CS data by policy
Expectation management therefore may be needed when implementing CS, as both scientists and participants in CS projects may have high expectations about the policy impact of their engagement
Participation bias
Publication bias towards successful projects
Temporal gaps between scientific process and policy needs
Lag of management action on findings
Open data policy agenda needs further discussion in the CS community
CS data needs to be suitable not only for policy decision- making, but also available, fit-for-purpose, robust, and timely to be uptaken by policy.
Authorities embrace collaboration with the public, they do not have answers to many questions, such as how to handle CS data and feed them into existing information flows, or how to reconcile CS data with data from other sources
Operational, organisational, and governance issues are addressed twice as often as data or policy issues
Some policy documents state that project leaders should consider the overall suitability of CS as an approach to the given issue of concern; ensure proper project design, planning, and development; and consider the incentives and motivation for participants if they want to meet policy goals
These include the lack of recognition of the value of CS by scientific communities as well as by the policy communities This lack of recognition might result in the lack of willingness to incorporate CS project results into policy and calls for a better understanding of the current use of CS data as evidence for policy
Tracing the influence of CS projects on decision-making could be challenging, however, because policy decision making is a complex process
More study is needed about how CS data are translated into the design of new policies and, respectively, the revision of existing policies

Another reason for why it may be hard to assess the impact of citizen science efforts on public policy is the relative lack of formal evaluations of CS projects. According to some policy documents, “evaluations of the monitoring of data quality and data collation are often not undertaken”
One document mentions a lack of spontaneous collaboration between authorities and CS on local concerns
“Political and financial guarantees for action on findings”
For policy decision-making, scientific evidence contributes to some but not all of the decision-making process
There may be a risk to focus policies only on obvious issues, while not tackling more complicated or intangible issues CS is assumed to work best on hands-on problems where many volunteers can contribute directly, while less obvious issues might not attract people to participate
Need for the provision of guidelines and supporting frameworks
Fail to emphasise the opportunity for policy organisations to promote dialogue through CS with those people most interested in the policy topic under consideration of CS projects
CS is framed as a tool for science and as a means for collaboration between science and society, while the assessed policy documents do not perceive a clear function for policy to drive or participate in the CS processes itself
Missing integration of CS in education
The potential of conflict due to citizen science
Citizen science in its civic/community science form might seem inherently confrontational, especially at the local and city level, where the community collects information to oppose or challenge local industrial facilities or future plans by local authorities, or even a case of “Not In My Back Yard” (NIMBY)
Many aspects of the processes that are required to generate such citizen science initiatives often do not fit within current institutional practices
Additional efforts that are needed to realise citizen science projects, including time investment in relationship building and co-creation processes with participants and policymakers, are undervalued
ECONOMIC
Sustainability of CS projects
Affordability and accessibility for participation to representatives from a broad range of cs

communities
Although the collection of data by citizens may reduce costs, features specific to CS projects may incur costs that might be escalating, such as attracting participants or the growth of a project in scale and number of volunteers
Insufficient support and resources, for example for educators who want to encourage their students to participate, may pose threats for projects. Policy documents call for training, guidance, and feedback for CS project participants in data acquisition methods, which need time and resources, and which have to be provided in accessible formats for the targeted audience
Insufficient funding
Academic institutional practices frustrate further growth and acceptance of cs. Academic career paths still largely rely on having a strong publication record in high-ranking academic journals and securing large scientific grants.
SOCIAL
Involvement of and maintaining the motivation of volunteers
Civic engagement patterns in Poland, Slovenia, Lithuania or Romania influenced by a past heritage of “compulsory volunteering”
Distinct capacities of “professional” versus “volunteer” CS practitioners: day and time of the week to hold such events, the availability of travel cost support, or the possibility of compensating freelance workshop organisers
Interconnection, knowledge exchange and synergies between CS projects and communities
Communication, motivation and volunteer collaboration
Exclusion through digital technology
“Perception of data quality rather than the actual data quality”
CS needs to gain the acceptance and the recognition of the scientific community as well as of “potential end-users of volunteer-gathered data”
need for knowledge exchange and interconnection of CS projects is expressed, for example, through information hubs and registers of projects serving as connecting service for practitioners and researchers; or through fora “to foster a regular dialogue between policy makers, mediators and practitioners”
A range of challenges is addressed for CS projects concerning communication and collaboration with participants on equal terms, including timely and adequate feedback and recognition of their engagement to sustain participation and to build and maintain trust

Reasons that might prevent participation in CS are educational background or limited access to technology, such as digital devices as well as knowledge or affinity to use them or the inclusion of certain groups that excludes others, such as technically less-literate audiences.
CS projects need flexibility to “accommodate the views and knowledge of citizens”
At the same time, when citizen science projects rely on voluntary contributions, there may be no guarantee that the data will be collected and delivered, and CS, therefore, may not always be reliable for supporting official reporting duties.
Concerns also relate to the aspect that the different existing and emerging communities, which deal with various thematic topics, apply specific internal standards, such as for data provision in specific formats
Moreover, there are concerns that due to Internet solutions, direct interactions between participants, project leaders, and policymakers may be reduced and thus the opportunities for and the quality of joint discussions diminished
Other aspects that should be considered, according to some policy documents, especially when projects take place across larger spatial scales, are language, culture, and history of the participants for example, promotional material and training should be offered in a way that the target audience can understand
Societal imbalance
Changes in attitude of participants, such as “towards science and the environment, and environmental behaviours,” are “notoriously difficult to measure”
Policy calls for involvement of citizen scientists and that CS should take care to represent and involve all sections of society in CS projects to avoid current participation bias in CS
The societal and technological transitions provide a portrait of the average participant in citizen science activities – well educated, working in a job that provides enough income and working conditions for ample leisure, and with access to the internet as well as ownership of smartphones
A purposeful activity must be designed to reach the target group and engage them in an effective way
TECHNOLOGY
CS data perceived perceived problematic quality and reliability of data
User-friendliness of databases (e.g. data scattered across different portals)
Critical attitude towards CS data: when was the observation done and who was the observer, knowledge?

Reliability and quality of CS data
Re-usability of solutions (data, tools or apps)
Standardisation of data and meta-data
Access and interoperability of data
Internal project standards and use of tools
Data analysis and data accessibility
Interoperability with other data sets or policy reporting needs
The interoperability of contents and platforms
The integration of CS data with traditional sources of information
Information systems should be flexible and make the reuse of data possible as well as provide possibilities for “long-term data archiving, curation, access and re-use”
Policy documents urge for collaboration on technical issues across networks to create synergies while stating a lack of overview on existing tools and a fragmentation of data
Reliability of data as participant might not deliver data at all or not strictly adhere to protocols
Interoperability arrangements between the data published by public administrations and that published by the public either as individuals or as part of organised citizen science initiatives
CS data are often not easily accessible, as they are embedded in project websites
Furthermore, the “high turnover of new apps” and “high development costs”
Justification is recommended concerning why a CS approach is chosen for data collection in addition to professional data
ENVIRONMENT
Belief that CS data gathering lacks common methodologies and standards for reporting
Citizen and DIY science represent recent and rapidly developing phenomena
Critical voices that question CS in its current conceptualization have emerged
Reliability, credibility and quality assurance
The assumption that the work of “amateur” experts may be perceived within the scientific community as substandard, unreliable, or of doubtful quality is portrayed as one of the biggest challenges for cs
Sometimes not submitted to peer review and critical scientific appraisal

Is CS open science?
Risk of misinterpretation of results or misunderstanding what the scientific literature is saying about the issue
Opening up of local and indigenous knowledge across the world, through its integration in citizen science. The increase in recording of information can lead, inadvertently, to the release of sensitive information such as the location of an endangered species
LEGAL
Representativeness and ethical issues such as privacy, legal issues and related quality control or ownership of data
Legal frameworks could address issues such as data privacy and ownership.
The potential risks from DIY Science activities

4. Policy landscape review at the European level

Today’s policymakers face the responsibility of addressing new and increasingly complex challenges to safeguard the environment and public health. To support the efforts for continuous improvement in member-states, EC in many ways encourages citizen science through targeted strategies, funding of projects, specific policies, research, and programmes.

The United Nations Economic Commission for Europe (UNECE) Aarhus convention of 1998 provides EU citizens with the right to participate in environmental decision-making.

The role of the citizens and their contribution to the science and policymaking process increased significantly over the past 30 years. The start was made with the 5th Framework Programme (FP5 - 1998–2002) which included “raising public awareness of science and technology”. The next period - the 6th Framework Programme (FP6 - 2002–2006) was supported by a specific action plan — “Science and Society”. The new formulation was presented in the 7th Framework Programme (FP7- 2007–2013) - the “Science in Society”. All that experience was incorporated in the Horizon 2020 (H2020) “Science with and for Society”

with the aims to build effective cooperation between science and society, recruit new talent for science, and pair scientific excellence with social awareness and responsibility.

The LIFE Programme is the EU's funding instrument for the environment and climate action that supports active collaboration between scientists, public administrations, and citizens.

Providing financial support for the CS projects shows the importance of the future EU sustainable development. Knowledge is a powerful instrument and in order to foster collaboration between partners across academia, industry, public authorities, and citizen groups, the EU provides policy initiatives, funding schemes, and support services related to open innovation and open science. Open Innovation means that civil society, science, industry, and government work together in dynamic, diverse innovation ecosystems. With the EU Open science approach, the researchers shared their knowledge and data with partners from across academia, industry, public authorities, and citizen groups and invited them to participate in the research and innovation process.

The European Union Prize for Citizen Science is the latest initiative focused on CS importance. The prize recognizes outstanding achievements in the advancement of knowledge through the empowerment of civil society in the development of the future and honours CS initiatives in the European Research Area that enact change, expand knowledge, and demonstrate innovative Open Science processes that rethink existing practices while addressing social, cultural, environmental, educational, and political advancement.

Citizen science is supported by a wide number of European policies and programmes:

- COST (European Cooperation in Science and Technology) is a funding organisation for research and innovation networks. A COST Action is an interdisciplinary research network that brings researchers and innovators together to investigate a topic of their choice for 4 years. COST Action CA15212 - The Citizen Science COST Action promoted creativity, scientific literacy, and innovation throughout Europe. The main aim of this Action was to bundle capacities across Europe to investigate and extend the impact of the scientific, educational, policy, and civic outcomes of citizen science with the stakeholders from all sectors concerned (e.g., policymakers, social innovators, citizens, cultural organisations, researchers, charities and non-governmental organisations), to gauge the potential of citizen science as an enabler of social innovation and socio-ecological transition².
- Science with and for Society under Horizon 2020 supported societal engagement and citizen science. Through this part of the programme, 25 projects received EUR 65 million³.
- Horizon 2020 funds citizen science through ICT programmes, in particular through collective awareness platforms for sustainable and social innovation (CAPS)⁴ - CAPS projects are ICT-enabled pilot initiatives, which address pressing social issues and sustainability issues by promoting the active participation of European citizens and/or rely on their capability of proving and sharing information. CAPS projects are digital social innovation initiatives and as such are expected to propose innovative solutions

² <https://cs-eu.net/>

³ [Science with and for Society](#)

⁴ [CAPS](#)

which should be more efficient, effective, just and sustainable than available ones. CAPS initiatives are multidisciplinary in nature and most of them have a relevant research aspect.

- Horizon Europe prioritises co-design and co-creation, and expects to create impact through co-creation with citizens and end users. Applicants are encouraged to consider open science practices and include citizens and societal engagement in their methodology as this aspect is part of the evaluation process. Specific guidance on societal engagement can be found in the [Horizon Europe Programme Guide](#).

The policy landscape review on the European level is based on the study of the reports and guidelines of the EC and European Environmental Agency (EEA) and the most relevant citizen science-related policy documents (reports, plans, strategies, methodologies, roadmaps, white and green papers, tools, etc.). In the end, 50 documents were selected. Some of the citizen science projects (SOCIENTIZE, ACTION, WeObserve, EU-Citizen.Science, WeCount, MOBIMIX, cities.multimodal) end with the development of strategic documents, resource materials and tools.

The documents are divided in three categories - Observation and information, Tools and Government policy.

Category 1 Observation and information – this category includes documents such as reports and policy briefs. In this category 27 documents were found, most of them are reports.

For the implementation of CS projects, it is extremely important to correctly develop a strategy for standardised collection, processing and visualisation of the data. This could be done by formulation of recommendations, guidelines, and protocols on how to gather data and observation by the public in a systematic way by scientists. Citizen science covers many different fields and this requires the use of different approaches. For this reason, the number of documents in this category is the largest.

Table 3: European CS policy related documents overview - Category 1

Category 1 Observation and information					
No	Name of the document with link	Document type	Source of information	Short description	Purpose
1	Assessing air quality through citizen science	report	EEA	provides a non-technical summary of the types of options and tools now available for citizens to measure their local air quality	raising usage of AQ sensors

Category 1 Observation and information					
No	Name of the document with link	Document type	Source of information	Short description	Purpose
2	Best Practices in Citizen Science for Environmental Monitoring	report	EC	summarises the opportunities for and benefits of using citizen science for environmental monitoring, highlights good practices and lessons learnt, and identifies the obstacles preventing its broader uptake	improved knowledge base, more accountable, informed open society, societal relevance of policy measures, empowering people, creation of networks and partnerships
3	Citizen science for sustainable urban mobility: Empowering citizen traffic counters to shape local policy	policy	WeCount project	The policy brief showcasing real-life examples for achieving change by proactive citizens in co-designing local traffic policies	to engage residents and to generate data and momentum, while supporting research on street safety and pollution.
4	How to choose a governance approach for the deployment of shared mobility solutions	policy	MOBI-MIX project	decision-making framework that supports cities to make an informed choice for a governance approach that simultaneously assesses the impact on the city goals and the business cases of mobility providers	to show what decisions a city can make for implementation of new shared mobility solutions in the urban environment and how to assess their impact
5	Mutual Learning Exercise on Citizen Science Initiatives - Policy and Practice Topic Four Discussion Paper: Enabling Environments for Supporting and Sustaining Citizen Science	report	EC	Focuses on the institutional and governance arrangements within the Member States that can support and sustain citizen science and citizen engagement over the longer term.	to facilitate the exchange of information, experience and lessons, as well as to identify good practices, policies and programmes in relation to varying approaches at local, regional and national levels, towards supporting and scaling up citizen science

Category 1 Observation and information					
No	Name of the document with link	Document type	Source of information	Short description	Purpose
6	Civil society participation in EU governance	review	Living Reviews in European Governance Journal	reviewed civil society participation in EU governance	presents the two dominant analytical perspectives on civil society participation: the notion of civil society as organised actors that contribute actively to multilevel governance, and civil society as the model for an emerging European public sphere.
7	European Clean Air Day - citizen science for clean air	policy brief	DITOs Citizen Science Policy Brief #8	This policy brief presents a framework for organising a yearly European Clean Air Day, starting from 20th June 2019	The objective is to scaling up European awareness of air quality issues, and ways in which air quality can be improved. The brief presents a range of financing options and tools for air quality monitoring within grassroots organisations.
8	A Roadmap for Citizen Science in GEO - The essence of the Lisbon Declaration. WeObserve policy brief 1	roadmap	WeObserve project	Describes how best to connect and integrate Citizen Science communities as well as their activities and outputs into GEO.	to summarises key messages from the Lisbon Declaration for European policymakers to advocate its importance and significance
9	Citizen Science for Policy Across Europe	report	EU-Citizen. Science platform	Contains the information, resources, conclusion and survey results of the High-Level Policy Event "Citizen Science for Policy across Europe" held online on June 22nd 2021 within the context of the European	To show the benefits of CS for policy making and to develop collaborations among policymakers with citizen science interests.

Category 1 Observation and information					
No	Name of the document with link	Document type	Source of information	Short description	Purpose
				Research and Innovation Days 2021	
10	Alternative Imaginaries: Citizen Mobility Futures	report	JRC	The report summarises key findings and recommendations arising from a number of citizen engagement activities conducted by the JRC from May – October 2019 concerning the future of mobility	The alternative imaginaries that citizens put forth mostly prioritised active modes of transport in cities such as biking and walking and put an emphasis on multimodality and interoperability. In part due to their diversity, the participants in the engagement activities focused on mobility solutions which addressed a variety of needs—for urban and suburban dwellers, for various demographics, and countries. Furthermore, citizens tended to focus on the environment and on the lifestyles of mobility users, with an emphasis on sustainability, accessibility and liveability.
11	Citizen Engagement in Science and Policy-Making	report	JRC	The report aims to demonstrate citizen engagement in science and policy development	Aims to show citizen engagement in science and policy development at different levels, ranging from public consultation to stakeholder

Category 1 Observation and information					
No	Name of the document with link	Document type	Source of information	Short description	Purpose
					engagement, to citizen science and DIY practices
12	Do It Yourself Science: Issues of Quality	report	JRC	Describes challenges in the interaction of DIY Science and established science.	The established science loses its monopoly of accredited status in the provision of knowledge and advice. One of the internal DIY Science challenges is the quality assurance of scientific production. The overcome should be the product of new thinking and new practices, enriching science in many ways as the two streams interact.
13	Citizen Science Initiatives – Policy and Practice Fifth Thematic Report: Scaling up citizen science	report	EC	This Thematic Report focuses on the meaning(s) and dimensions of scalability, drivers, success factors, challenges and best practices of scaling up CS projects in Europe, with an emphasis on the uptake for policymakers	the aim of this Thematic Report is to share the outcomes of the three working sessions held during the Berlin meeting and provide a list of eight key areas of actions for policymakers aimed at supporting the scaling up of CS projects and campaigns across Europe

Category 1 Observation and information					
No	Name of the document with link	Document type	Source of information	Short description	Purpose
14	Participatory science toolkit against pollution	tool	ACTION project	The toolkit is meant for pollution-focused citizen science projects of all kinds, and everyone who wishes to apply citizen science methods	The toolkit draws on expertise in citizen science, participatory design, social innovation, socio-economic studies, pollution, open science, social computing, open data and software development in the project team, to ensure it suits the requirements of citizen science projects, addressing the practical problems that they face throughout the different stages of each project
15	Co-creation Toolkit	tool	GoNano project	aims to enable co-creation between citizens, researchers, industry, civil society organisations and policy makers across Europe to align future nanotechnologies with societal needs and concerns	The toolkit offers a six-step approach to help researchers and engineers define their goal, identify the relevant stakeholders and design, implement and reflect on the co-creation process. GoNano hopes to inspire researchers and engineers to continue this journey, working together with citizens and societal stakeholders to create value in new settings, with new topics and with creative outcomes.

Category 1 Observation and information					
No	Name of the document with link	Document type	Source of information	Short description	Purpose
16	Citizen Science and Policy: A European Perspective	report	Wilson Center, Research institute	The report explores the intersection of citizen science and policy at local, regional, and national levels and across policy domains, on the basis of the emerging experience in Europe	This report identifies areas where citizen science actively contributes to the formation of policy and also explores areas where we can expect to see further developments
17	Scaling up Citizen Science	report	JRC	a theoretically grounded framework to unbundle the meaning of scaling and spreading in Citizen Science	to foster the spread and scalability in Citizen Science
18	Interactive Guidebook	guide	siscode project	guide for supporting co-creation in the field of Responsible Research and Innovation.	It presents methods, approaches and tools and makes them available for use.
19	DIY guidelines for citizen science projects in odour-conflicted communities	guideline	D-NOSES project	These guidelines aim to support citizen science projects operating in odour-conflicted communities. They are DIY guidelines – helping you to ‘do it yourself’ – and offer tested tools and practical tips for running projects and adapting them to different contexts.	support citizens to implement odour-related projects
20	Citizens Science and Environmental Monitoring	report	JRC	provide recommendations, stemming from all stakeholders, namely from the scientific, policy and citizens perspectives, on the way forward for improving developments, promoting and accelerating the use of Citizens Science for (environment-related) policy making throughout Europe	provide recommendations for improving developments, promoting and accelerating the use of Citizens Science for (environment-related) policy making throughout Europe

Category 1 Observation and information					
No	Name of the document with link	Document type	Source of information	Short description	Purpose
21	Briefing Paper on Citizen Science	briefing paper	Science Europe	This briefing paper looks in detail at the evolution of citizen science and citizen science policy, provides examples of initiatives from around the world, and considers the future of the activity.	traces the evolution of CS and summarise the examples of CS
22	Cities fit for the digital age	policy brief	JRC	describes how digital technologies and innovative solutions can act as enablers in enhancing services and contribute to improving the urban environment and the overall quality of life of its citizens.	Cities and communities should implement interoperable solutions, based on existing open standards and technical specifications, to avoid vendor-lock in, benefit from cross-domain, integrated services and infrastructures, reduce costs, and scale up successful projects.
23	Activity Report on Citizen Science	report	JRC	This report summarises main activities of the Citizen Science team-JRC, presents lessons learned and provides some reflections for future work. It is organised in a set of different areas of activities that the team was involved in and elaborated on major work items under each of these clusters, including some selected highlights.	It aims to provide evidence-based scientific support to the European policy making process.
24	ECSA's characteristics of citizen science	document	ECSA	The document represents a wide range of opinions in an inclusive way, to allow for different types of projects and programmes, where context-specific criteria can be set. The outlined characteristics are	These characteristics build on (and refer to) the ECSA 10 principles of citizen science as a summary of best practices – and projects are expected to engage meaningfully

Category 1 Observation and information					
No	Name of the document with link	Document type	Source of information	Short description	Purpose
				based on views expressed by researchers, practitioners, public officials and the wider public	with them.
25	Science for Policy Handbook	handbook	science-direct.com	provides advice on how to bring science to the attention of policymakers.	The handbook is dedicated to researchers and research organisations aiming to achieve policy impacts. The book includes lessons learned along the way, advice on new skills, practices for individual researchers, elements necessary for institutional change, and knowledge areas and processes in which to invest. It puts co-creation at the centre of Science for Policy 2.0, a more integrated model of knowledge-policy relationship.
26	Using new data sources for policy making	technical report	JRC	The report synthesises the results of our work on using new data sources for policy-making. It reflects a recent shift from more general considerations in the area of Big Data to a more dedicated investigation of Citizen Science, and it summarises the state of play	This is a starting point for promoting Citizen Science as an integral component of public participation in policy in Europe.

Category 1 Observation and information					
No	Name of the document with link	Document type	Source of information	Short description	Purpose
27	Review of practices of Higher Education engagement in citizen enhanced open science in the area of cultural heritage	report	CitizenHeritage project	Exploring the role of Higher Education Institutions (HEI) as incubators of the next generation open science citizens, in terms of staff and student skills, curricula and interdisciplinarity, and as institutions situated in a broader social context where citizens advocate a more important role in decision taking in modern societies with active citizenship, civic engagement, bottom-up public intervention, unlocking the still unused potential in connecting the user engagement generated through civic participation with the open science cycle.	to set up the role of HEI as incubators of the next generation open science citizens

Citizen science is emerging as a practice that can be a powerful addition to policy making because it can effectively contribute to all aspects of the policymaking process. There is widespread evidence that citizen science can expand the scientific knowledge base by mobilising un-biased, local, and expert knowledge or by carrying out research in places and at scales that would not have been possible otherwise⁵. Citizen science has been instrumental in the early detection of environmental issues (BIO Intelligence Service 2010). The potential of citizen science for developing a cost-effective evidence base and for engaging the wider public has been officially recognized in Europe. As proof, the European Environmental Agency published Report No 19/2019 - Assessing air quality through citizen science. The report presents examples of how low- cost devices have been used by citizen science initiatives to answer questions about air quality and explains how low-cost passive air pollutant samplers and air quality sensors work. It considers the reliability of the different devices in measuring air quality. It summarises how these devices can be used by individuals, within networks, and

⁵ [Newman et al. 2017](#),

on information service platforms. It also reflects on how such low-cost devices stimulate new approaches to addressing air quality issues.

The European Commission published in the summer 2020 Staff Working Document “Best practices in citizen science for environmental monitoring” (SWD(2020) 149 final) - an inventory of practices with an analysis of their contribution to sustainable development goals (SDGs). This document summarises citizen science's opportunities for and benefits of environmental monitoring, highlights good practices and lessons learned, and identifies the obstacles preventing its broader uptake. It also puts forward recommendations and possible actions for the various actors in the field (public authorities, citizen science networks, and communities, researchers/academics) to facilitate and enhance the use of citizen science in environmental monitoring. These recommendations are clustered around four areas: low-cost taking between knowledge needs and citizen science, promoting awareness, promoting standards for data quality and interoperability, and supporting coordination, cooperation, and resources for policy impact.

The policy brief “Citizen science for sustainable urban mobility: Empowering citizen traffic counters to shape local policy” showcases real-life examples of achieving change by proactive citizens. The main goal is to engage residents and generate data and momentum while supporting research on street safety and pollution.

A decision-making framework for public authorities on “How to choose a governance approach for the deployment of shared mobility solutions” was created in the frame of the MOBI-MIX project. The developed decision-making framework supports cities in making an informed choice for a governance approach that simultaneously assesses the impact on the city goals and the business cases of mobility providers. The decision-making framework includes many examples and insights about what decisions a city can make and how to assess their impact.

The report Mutual Learning Exercise on Citizen Science Initiatives - Policy and Practice/ Topic Four Discussion Paper: Enabling Environments for Supporting and Sustaining Citizen Science aims to facilitate the exchange of information, experience, and lessons, as well as to identify good practices, policies, and programmes with varying approaches at local, regional and national levels, towards supporting and scaling up citizen science.

The Living Reviews in European Governance Journal reviewed civil society participation in EU governance. This Living Review presents the two dominant analytical perspectives on civil society participation: the notion of civil society as organised actors that contribute actively to multilevel governance, and civil society as the model for an emerging European public sphere.

The policy brief European Clean Air Day - citizen science for clean air presents a framework for organising a yearly European Clean Air Day, starting from 20th June 2019, to scale up European awareness of air quality issues, and ways in which air quality can be improved. The brief presents a range of financing options and tools for air quality monitoring within grassroots organisations.

The Roadmap for Citizen Science in GEO - GEO is a global intergovernmental partnership that coordinates and improves the availability, access, and use of Earth Observation data for a sustainable planet. This policy brief summarises three key messages from the Lisbon Declaration for European policymakers to advocate its importance and significance:

- Support the consolidation of a Citizen Science federation as a common technical infrastructure through strong governance, privacy protection under the GDPR, and continuity in the European Citizen Science Association (ECSA).
- Connect the Citizen Science federation to the European Open Science Cloud (EOSC) as a scientific infrastructure and the GEOSS platform as a decision-making support infrastructure.
- Create and support a EuroGEO showcase on Citizen Science that continues the legacy of the current H2020 projects.

The roadmap describes how best to connect and integrate Citizen Science communities and their activities and outputs into GEO.

The Brief Policy Report "Citizen Science for Policy across Europe" contains the information, resources, conclusion, and survey results of the High-Level Policy Event held online on June 22nd 2021, within the context of the European Research and Innovation Days 2021. This event was organised within the context of the EU-Citizen.Science project. It was curated by the Museum für Naturkunde Berlin, Mineco-FECYT, and Ibercivis and received the support of the European Commission, the Spanish Ministry of Science and Innovation, the Portuguese Ministry of Science and Technology and Higher Education and the German Federal Ministry of Education and Research.

In order to critically examine the underlying political and social narratives guiding connected and self-driving vehicle development, the JRC conducted a series of citizen engagement initiatives from May to October 2019 that resulted in a number of major findings and recommendations, summarised in the report *Alternative Imaginaries: Citizen Mobility Futures*. The alternative visions that residents presented emphasised multi-modality and interoperability and prioritised active transportation in cities like biking and walking. The participants in the engagement activities concentrated on mobility solutions that addressed a range of needs—for urban and suburban people, for diverse demographics, and countries. Citizens also tended to concentrate on the environment and mobility users' lifestyles, with a focus on sustainability, accessibility, and liveability

The JRC report *Citizen Engagement in Science and Policy-Making* aims to show citizen engagement in science and policy development at different levels, ranging from public consultation to stakeholder engagement, to citizen science and DIY practices.

The report *Do It Yourself Science: Issues of Quality* describes challenges in the interaction of DIY Science and established science. The monopoly of accredited status in the distribution of information and counsel is lost by the established science. The quality control of scientific production is one of the internal DIY Science problems. The solution should result from fresh ideas and innovative methods, improving science in a variety of ways as the two streams interact.

The JRC report *Citizen Science Initiatives – Policy and Practice Fifth Thematic Report: Scaling up citizen science* focuses on the definition(s) and dimensions of scalability, as well as its drivers, success factors, difficulties, and best practices when it comes to scaling up CS initiatives in Europe, with a particular emphasis on how policymakers may adopt it. The report

provides a list of eight key areas of actions for policymakers aimed at supporting the scaling up of CS projects and campaigns across Europe.

In the frame of the ACTION project a Participatory science toolkit against pollution. The toolkit is intended for all types of citizen science programs that focus on pollution and anyone else who wants to use citizen science techniques. The toolkit draws on expertise in citizen science, participatory design, social innovation, socio-economic studies, pollution, open science, social computing, open data and software development in the project team, to ensure it suits the requirements of citizen science projects, addressing the practical problems that they face throughout the different stages of each project.

The Co-creation Toolkit intends to facilitate the co-creation of future nanotechnologies with societal needs and concerns among citizens, researchers, industry, civil society organisations, and policy makers throughout Europe. The toolkit provides a six-step procedure to assist researchers and engineers in defining their purpose, locating the pertinent stakeholders, designing, putting the co-creation process into practice, and reflecting on it.

The report Citizen Science and Policy: A European Perspective examines how citizen science and policy connect at the local, regional, and national levels as well as across policy areas. In addition to highlighting areas where citizen science is actively influencing policy making, this research also looks at potential future developments.

The JRC report Scaling up Citizen Science proposes a theoretically grounded framework encompassing nine constructs that represent enablers of the complex phenomena of scaling and spreading in Citizen Science.

A manual for encouraging co-creation in the area of Responsible Research and Innovation is the SISCODE Interactive Guidebook. It offers for use and presents strategies, tactics, and resources. The guidebook is divided in two categories- Practitioner (who actively uses co-creation in projects or initiatives at all levels, from the organisational to the global) or as an Organizer/Planner/Researcher (plans for others' co-creation in projects or individual activities).

The guideline “DIY guidelines for citizen science projects in odour-conflicted communities” is dedicated to citizens living in odour conflicted regions who wish to take steps to address odour problems. The guideline is also helpful for other stakeholders in odour-conflicted situations: the guideline is also helpful for other stakeholders in odour-conflicted situations: policy-makers, local authorities and those responsible for the source of the pollution, including the odour emitting activities.

The report Citizens Science and Environmental Monitoring offers suggestions on how to move forward for improving advances, promoting, and accelerating the use of Citizens Science for (environment-related) policy making throughout Europe that come from all stakeholders, specifically from the scientific, policy, and citizens viewpoints.

The Briefing Paper on Citizen Science looks in detail at the evolution of citizen science and citizen science policy, provides examples of initiatives from around the world, and considers the future of the activity.

The policy brief *Cities fit for the digital age* explains how cutting-edge technologies and new approaches might be used to improve services, the urban environment, and the general quality of life for its residents. The experience shows that to avoid vendor lock-in, gain access to cross-domain, integrated services and infrastructures, cut costs, and scale up successful initiatives, cities and communities should deploy interoperable solutions based on current open standards and technical specifications.

This Activity Report on Citizen Science covers lessons learned, summarises key actions of the Citizen Science team JRC, and offers some thoughts for further work. It is divided into a variety of distinct activity clusters in which the team participated and it elaborates on the significant work items that fall under each of these clusters, including a few chosen highlights.

To enable various initiatives and programmes where context-specific criteria can be specified, the ECSA's characteris of citizen science document provides a wide range of viewpoints in an inclusive manner. The mentioned traits are based on opinions shared by academics, professionals, government officials, and members of the general public.

The Science for Policy Handbook is intended for scholars and research institutions that want to have an impact on public policy. The book offers recommendations on developing new skills, practises for individual researchers, aspects required for institutional transformation, knowledge areas and processes to invest in, and lessons learnt along the way. It places co-creation at the heart of Science for Policy 2.0, a more comprehensive model of the link between knowledge and policy.

The findings using new data sources for policymaking report on utilising new data sources for policy-making are summarised in the report. It outlines the current situation and represents a recent transition from more general Big Data considerations to a more focused exploration of Citizen Science.

The report *Review of practices of Higher Education engagement in citizen enhanced open science in the area of cultural heritage* aims to exploring the role of Higher Education Institutions (HEI) as incubators of the next generation open science citizens, in terms of staff and student skills, curricula and interdisciplinarity, and as institutions situated in a broader social context where citizens advocate a more important role in decision taking in modern societies with active citizenship, civic engagement, bottom-up public intervention, unlocking the still unused potential in connecting the user engagement generated through civic participation with the open science cycle.

Category 2 Tools – this category includes documents such as tools, roadmaps and methodologies. In total 15 documents were found.

The availability of such documents supports CS activities and encourage broad participation of citizens groups across the EU.

Table 4: European CS policy related documents overview - Category 2 Tools

Category 2 Tools					
No	Name of the document with link	Document type	Source of information	Short description	Purpose
1	ROADMAP for the uptake of the Citizen Observatories' knowledge base	roadmap	WeObserve project	targeted at Citizen Observatory practitioners (research institutions, civil society organisations, public authorities and others) for conceptualising and directing key aspects of future Citizen Observatories; at national funding agencies of EU member states to identify potential scenarios for funding Citizen Observatories nationally; as well as for the European Commission as a consultation document for shaping Horizon Europe programme funding calls.	to outline a dynamic landscape and provide actionable pathways to further advance Citizen Observatories' capabilities and impacts in the future.
2	Recommendations for engagement and awareness raising in citizen science	methodology	EU-Citizen.Science project	The methodology details the critical components and considerations necessary and will aid practitioners in maximising impact across a range of stakeholder groups	to support practitioners in facilitating engagement with activities and initiatives and raising awareness about citizen science
3	Toolbox for Mobility Management	tool	cities.multipodal project	addresses stakeholders at different levels, including kindergartens, schools, companies and urban developments, in order to motivate them to set up local projects.	improved the conditions for their citizens to easily and smoothly combine walking, cycling, the use of public transport as well as shared mobility (bikes, cars, e-cars and bikes) as a more sustainable alternative to individual private car use
4	Catalogue of Policy Measures 2.0 Toward Sustainable Mobility	tool	Sustainable Mobility for All (SuM4All) Partnership	compiles all the policy instruments available to country decision-makers to achieve sustainable mobility	To prepare a set of measures and initial "prototype action plan"

Category 2 Tools					
No	Name of the document with link	Document type	Source of information	Short description	Purpose
5	Communication in Citizen Science	tool	Scivil, the Flemish Knowledge Centre for Citizen Science	guide on how to initiate a citizen science project	practical guide to communication and engagement in citizen science
6	BiodiverCities: A roadmap to enhance the biodiversity and green infrastructure of European cities by 2030	roadmap	JRC	The report collects practical examples of how to engage citizens in vision building around urban nature, monitoring, and solutions to improve urban biodiversity. And also mapping urban biodiversity and ecosystem services at European scale	Aims to improve civil society participation in decision-making, leading to building a joint vision of the green city shared among civil society, scientists and policymakers.
7	ROADMAP FOR CITIZEN SCIENCE	roadmap	CIVIC EPISTEMOLOGIES project	Describes participation of citizens in research on digital Cultural Heritage (CH) and humanities	The aim of this Roadmap is to illustrate a path towards the engagement of citizens in the research and valorisation of CH, by using distributed services like digital tools and online communication offered by the e-Infrastructures
8	Policy Roadmap on Research infrastructures for citizen science in Europe	roadmap	REINFORCE project	Minimising the knowledge gap between Large Research Infrastructures and Society through Citizen Science	The aim of this roadmap is to put forward a set of policy recommendations that should be followed in order to make research infrastructures a key player in citizen science through a consistent involvement of citizens

Category 2 Tools					
No	Name of the document with link	Document type	Source of information	Short description	Purpose
9	The Reflection Tool for institutional changes in Citizen Science	tool	TIME4CS project	the tools is is dedicated to anyone that would like to pursue sustainable institutional changes towards Citizen Science	The instrument can be used to specify the Grounding Activities, or the actions that support or implement institutional changes. You can use it as a reference to help you reflect on the big picture, identify the pertinent stakeholders, define the success criteria for the actions, highlight the essential resources, identify potential obstacles, and create a timeline for the specific actions required to bring about lasting change.
10	Citizen Science Toolkit for biodiversity scientists	tool	BiodivERsA project	The toolkit aims to improve the understanding of Citizen Science practices and overcome potential barriers in research projects.	The main aim is to inform scientists working in the fields of biodiversity and, more generally, in environmental sciences, about the potential benefits of Citizen Science, and to provide a summary of the rationale to develop Citizen Science, current best practices, and useful resources in the field
11	The Inspiration Catalogue	guide	CIMULACT project	the guide presenting methods for conducting work with citizens and stakeholders.	presenting methods for conducting work with citizens and stakeholders.
12	Co-creating European Futures – Innovation, Participation and Co-creation in Europe 2030	roadmap	SCALINGS project	The purpose of this roadmap is to guide co-creation actors towards designing and implementing socially inclusive and responsible co-creation activities	The roadmap is designed to help orient co-creation actors towards more responsible, socially just and inclusive forms of innovation. The roadmap offers a set of criteria formulated as assessment questions that empower co-creation actors to design co-

Category 2 Tools					
No	Name of the document with link	Document type	Source of information	Short description	Purpose
					creation activities that will work in their specific context.
13	Practitioner roadmap and methodology toolkits	methodology	SciShops project	provides guidelines on how to implement research and non research projects in the context of Science Shops	providing insights, tools and methods, as well as specific Responsible Research Innovation (RRI) tools for effective knowledge exchange in the CBPR process between Science Shops and civil society.
14	Strategic Roadmap for governance in odour pollution	roadmap	D-NOSES project	positions objectives and strategies to pave the way for future regulations in odour pollution in the medium and long term.	aims to provide objectives and strategies in the medium to long term (5-10 years) to pave the way for a more inclusive and sustainable regulatory framework in odour pollution
15	Methodology, user requirements and guidelines for Cultural Heritage Institutions and Universities	methodology	CitizenHeritage project	Improving methodologies of co-creation and user engagement with cultural heritage with better alignment within the educational context, also making students in Cultural Studies and Humanities closer to Cultural Heritage Institutions, thus lowering the threshold between the university and the later employment field.	improves approaches of co-creation and user engagement with cultural heritage with better alignment within the educational context

The WeObserve project brought together several Citizen Observatory projects to share and consolidate knowledge and identify best practices. Many insights gained have been synthesised into a detailed research and innovation roadmap for future Citizen Observatories, outlining focus areas, dedicated pathways, and proposed actions. The WeObserve roadmap outlines a dynamic landscape and provides actionable pathways to advance other Citizen Observatories' capabilities and impacts in the future. It is targeted at Citizen Observatory

practitioners (research institutions, civil society organisations, public authorities, and others) for conceptualising and directing key aspects of future Citizen Observatories. National funding agencies of EU member states to identify potential scenarios for funding Citizen Observatories nationally and for the European Commission as a consultation document for shaping Horizon Europe program funding calls.

The methodology “Recommendations for engagement and awareness-raising in citizen science” details the critical components and considerations necessary. It was created to support practitioners in facilitating engagement with activities and initiatives, maximising impact across a range of stakeholder groups (including policymakers), and raising awareness about citizen science.

The Toolbox for Mobility Management provides knowledge on Mobility Management as an essential approach to promoting sustainable and multimodal travel behaviour. The Toolbox addresses stakeholders at kindergartens, schools, companies, and urban developments to motivate them to set up local projects. One dedicated chapter for each target group informs about objectives and tips for engaging in and implementing Mobility Management. The main goal is to improve the conditions for their citizens to easily and smoothly combine walking, cycling, public transport, and shared mobility (bikes, cars, e-cars, and bikes) as a more sustainable alternative to individual private car use.

Catalogue of Policy Measures (CPM) 2.0 Toward Sustainable Mobility compiles all the policy instruments available to country decision-makers to achieve sustainable mobility to prepare a set of measures and an initial "prototype action plan". The CPM compiles the collective knowledge of 56 international organisations and private companies on instruments available to country decision-makers on how to achieve sustainable mobility. It is a one-stop tool that enables users to access curated global policy knowledge on transport policy. The original CPM, which was published in 2019, included 180 policy instruments and was further upgraded in 2022 as follows: 12 policy instruments were added to account for sanitary risks in the face of the COVID 19 pandemic (For example, added measures include “enhanced sanitary protocols in passenger transport”, “use of transport operator data to inform policy response”, and the “support of cross-border trade of essential goods during crisis response”); more granularity on several policy instruments is reflective of additional work done by the Partnership on data sharing, e-mobility, and transport and energy nexus.

The tool “Communication in Citizen Science” is a practical guide for communication and engagement in citizen science and how to initiate a citizen science project.

The BiodiverCities: A roadmap to enhance the biodiversity and green infrastructure of European cities by 2030 compiles real-world instances of citizen involvement in vision creation, monitoring, and solutions to enhance urban biodiversity. Moreover, tracking European-scale urban biodiversity and ecological services aims to increase the involvement of civil society in decision-making, which will contribute to the development of a shared vision of the green city among civil society, scientists, and politicians.

The ROADMAP FOR CITIZEN SCIENCE is designed to show how individuals can be involved in the study and appreciation of cultural heritage through the use of dispersed services like digital tools and online communication provided by e-Infrastructures.

The goal of the Policy Roadmap on Research Infrastructures for Citizen Science in Europe is to present a collection of policy suggestions that should be implemented in order to make research infrastructures an important player in citizen science by regularly involving citizens and to minimising the knowledge gap between Large Research Infrastructures and Society through Citizen Science.

The Grounding Activities, or the actions that support or implement institutional changes, can be described using the Reflection Tool for institutional changes in citizen science. It can serve as a resource to assist you in thinking about the big picture, identifying the relevant stakeholders, defining the success criteria for the actions, highlighting the crucial resources, spotting potential roadblocks, and developing a timeline for the precise actions needed to effect long-lasting change.

The Citizen Science Toolkit for Biodiversity Scientists seeks to advance knowledge of Citizen Science procedures and remove obstacles that could arise in research endeavours. It can be used to provide a summary of the motivation behind the development of citizen science, current best practices, and helpful resources in the field, as well as to inform scientists working in the fields of biodiversity and, more generally, environmental sciences, about the potential benefits of citizen science.

The Inspiration Catalogue presents methods for conducting work with citizens and stakeholders.

The Co-creating European Futures – Innovation, Participation and Co-creation in Europe 2030 roadmap is intended to guide participants in co-creation towards more responsible, equitable, and inclusive forms of innovation. In order to help co-creation actors create co-creation activities that are appropriate for their particular environment, the roadmap provides a set of criteria that are presented as assessment questions.

The Practitioner roadmap and methodology toolkits provide guidelines on how to implement research and non research projects in the context of Science Shops.

The Strategic Roadmap for governance in odour pollution aims to provide objectives and strategies in the medium to long term (5-10 years) to pave the way for a more inclusive and sustainable regulatory framework in odour pollution.

The Methodology, user requirements and guidelines for Cultural Heritage Institutions and Universities improves approaches of co-creation and user engagement with cultural heritage with better alignment within the educational context.

Category 3 Government policy - this category includes documents such as white and green papers and strategies. In total 8 documents were found.

The Green papers are documents with aims to stimulate discussion on given topics at EU level. The White paper aims to launch a debate with the public, stakeholders, policymakers in order to arrive at a political consensus.

Table 5: European CS policy related documents overview Category 3 - Government policy

Category 3 Government policy					
No	Name of the document with link	Document type	Source of information	Short description	Purpose
1	WHITE PAPER ON CITIZEN SCIENCE FOR EUROPE	white paper	SOCIEN TIZE Project	presents the challenges of citizen science at European level for researchers, the industry, policy-makers and civil society. Public engagement, openness, effectiveness, trust and education	science-society-policy interactions improvement
2	Green Paper on Citizen Science in Europe	green paper	SOCIEN TIZE Project	puts forward recommendations and possible actions to facilitate and enhance the use of citizen science in environmental monitoring	to foster the interaction between the Citizen Science stakeholders and the EU policy officers
3	White Paper of Science Innovation Through Citizen Science	white paper	ACTION project	explores the potential for learning from, and the practice of, citizen science to foster innovation in science. Citizen science, operating both within and outside of established research organisations and engaging with civil society has the potential to feed back into science not only in terms of social aspects of how and by whom science is done, but also in terms of impact on the concrete outcomes of scientific research. This document takes a sociological and political perspective on the opportunities offered by citizen science for facing existing challenges within the practice of science.	It aims to communicate to scientific researchers and policymakers involved in citizen science the under-explored potential for innovation within scientific practice from advances made in the practice of citizen science.

Category 3 Government policy					
No	Name of the document with link	Document type	Source of information	Short description	Purpose
4	High-Tech Strategy Innovations for Germany	strategy	EC	The strategy aims to ensure coherence within Germany's innovation policy, and to strengthen prosperity and economic growth in Germany.	The German government decided to get the public involved in the innovation process, with greater attention being given to public participation, citizens' readiness to embrace new technologies, and social innovation. The German government is re-thinking the way in which it is providing funding for research so as to ensure greater transparency and coherence.
5	Strategy for participatory research in communities and capacity building of existing science shops	strategy	SciShops project	The purpose of this strategy is to provide a vision and guidance to support the future development and capacity building of Science Shops. The strategy is designed to help Science Shops engage in 'transformative' community-based participatory research (CBPR), i.e. implement projects on behalf and with CSOs that inspire and enable changes or result in new perspectives on the issues under investigation.	The strategy identifies concrete ways to develop Science Shops with transformative potential by describing priorities, objectives and actions for strengthening knowledge exchange between Science Shops and society, and supporting the capacity building of Science Shops.
6	Green Paper on Odour Pollution	green paper	D-NOSES project	aims to place odour pollution in the policy agendas by providing recommendations to better tackle the issue and move towards an improved regulatory framework in Europe	advocates for the need of a bottom-up, multi-level governance model in odour pollution within Europe in order to protect the affected citizens and support the environmental authorities and emitting activities in order to improve the situation

Category 3 Government policy					
No	Name of the document with link	Document type	Source of information	Short description	Purpose
7	Science Europe Strategy 2021–2026	strategy	Science Europe	includes an updated vision, mission, values, and set of strategic priorities for the association	Science Europe will engage new areas such as research culture and the role and contribution of science in society. It will also better support Science Europe's Member Organisation in their mission to create world-class scientific knowledge, delivering more benefits for our societies.
8	Open innovation, open science, open to the world. A vision for Europe	strategy	EC	to show the need for changes in research and innovation due to the digital developments.	Digital technologies are making the conduct of science and innovation more collaborative, more international and more open to citizens. Europe must embrace these changes and reinforce its position as the leading continent for science, for new ideas, and for investing sustainably in the future.

Some of the citizen science projects end with the development of strategic documents.

In Europe, the White Paper on Citizen Science⁶ establishes CS as a strategy for future research. Countries with a long tradition of public participation in studies, such as Germany and the UK, are developing national strategies to enhance capacity building for CS. Citizen engagement is essential to good governance, improved science-society-policy interaction, and more democratic research⁷. In a broader context, CS is seen as a way to broaden public participation in science by fostering dialogue between lay people, experts, scientists, and policymakers⁸.

The Green Paper on Citizen Science aims to foster the interaction between the Citizen Science stakeholders and the EU policy officers, reinforcing the culture of consultation and dialogue in the EU. Interaction between the European Institutions and society takes various

⁶ White Paper on Citizen Science [Sanz et al., 2013](#)

⁷ [Hinchliffe, Levidow, & Oreszczyn, 2014](#)

⁸ [Bonney et al., 2009](#)

forms, primarily via the European Parliament, institutionalised advisory bodies of the EU, and less formalised direct contacts with interested parties.

As a result of the implementation of the ACTION project (Participatory science toolkit against pollution) has been created White Paper of Science Innovation Through Citizen Science. The document explores the potential for learning from and practising citizen science to foster innovation in science. Citizen science, operating within and outside of established research organisations and engaging with civil society, has the potential to feed back into science not only in terms of social aspects of how and by whom science is done but also in terms of its impact on the concrete outcomes of scientific research. This document takes a sociological and political perspective on the opportunities offered by citizen science for facing existing challenges within the practice of science. It aims to communicate to scientific researchers and policymakers involved in citizen science the under-explored potential for innovation within the scientific approach from advances made in citizen science.

The new High-Tech Strategy Innovations for Germany aims to advance Germany's progress towards becoming a global innovation leader. The intention is for creative products and services to be produced fast from good ideas. It is a comprehensive, inter departmental innovation strategy and also includes instruments for funding innovation.

The Strategy for participatory research in communities and capacity building of existing science shops outlines priorities, objectives, and activities for enhancing knowledge exchange between Science Shops and society and supporting the capacity building of Science Shops in order to establish and develop Science Shops with transformative potential.

The Green Paper on Odour Pollution is a policy document that offers suggestions on how to better address the problem and advance towards an improved regulatory framework in Europe. Its goal is to bring odour pollution to the attention of policymakers.

The Science Europe Strategy 2021-2026 will assist Science Europe Member Organizations in their goal to advance our society by producing knowledge of the highest calibre. The strategy describes how the association of research funders and performers, located in Brussels, will direct the creation of European Research Area (ERA) policies and create the most robust research environment for the benefit of science, researchers, and society. And also highlights initiatives that are now underway or in the planning stages and pulls together some of the fundamental basic ideas underlying open innovation, open science, and open to the world.

These strategic documents (Green and white papers) support CS, encourage its implementation and contain recommendations for its development. This led to concrete political actions. For example - forming of funding schemes in Germany. The German citizen science platform "Bürger schaffen Wissen" has been receiving funding from the Federal Ministry of Education and Research (BMBF).

Belgium has created the knowledge centre for Citizen Science in Flanders - Scivil. Scivil was founded with funding from the Flemish government (department of Economy, Science and Innovation) to unite, support and inform scientists, citizens, policymakers and organisations about citizen science.

The rise of CS is supported by a variety of organisations. At the European level, such a supporting organisation is the European Citizen Science Association (ECSA). ECSA was set up to encourage the growth of citizen science in Europe, and to support the participation of the general public in research processes – across science, social science, humanities and the arts. This is a network of organisations and individuals, such as research institutes, museums, students and universities, NGOs and CSOs, the private sector and citizen science groups. It seeks to promote the benefits and impacts of Citizen Science to policymakers and those who influence them, to collect case studies and research evidence about policy outcomes of Citizen Science activities, as well as to represent policy-related goals and achievements to ECSA's members and governance structures.

In 2021 the European Commission launched a new centre to build partnerships and provide guidance, tools and resources to strengthen citizen engagement in policy: the competence centre on participatory and deliberative democracy.

5. Policy landscape review of COMPAIR pilot areas

The following pilot countries each established a local/regional CS lab with a specific focus:

- Greece - Athens - reducing our carbon footprint for better air quality
- Germany - Berlin - creating liveable spaces through open data
- Belgium - Flanders - improving personal exposure to air pollutants
- Bulgaria - Sofia & Plovdiv - exploring environmental issues related to commuting

During the implementation of Task 2.2 we identified the CS initiatives in each of the pilot areas. The citizen science landscape review highlighted that:

- In Bulgaria and Greece, there is a notable lack of sources providing information on the national CS landscape, its size, diversity and main characteristics.
- The number of CS projects and initiatives in Bulgaria and Greece is very low
- A lack of national funding schemes for CS in Bulgaria and Greece
- The country's CS landscape in Germany is arguably one of the most advanced in Europe. Over the years, hundreds of projects have been funded by the Federal Ministry for Education and Research to involve citizens in all scientific research, from monitoring air quality to identifying invasive alien species.
- Belgium has a buoyant CS landscape. There is a Flemish CS strategy and two platforms dedicated to citizen science.

The COMPAIR project aims to tackle the issue of poor air quality and climate change. For this reason, local environmental (air quality) plans and plans for sustainable urban mobility in pilot areas will be reviewed.

This can be summarised in the following table:

Table 6: Local specifics in the pilot countries

	Belgium	Bulgaria	Germany	Greece
Number of CS projects	more than 180	around 30	more than 150	around 30
National platform for CS	yes	no	yes	no
Project platforms (depends on initiative - when it's possible)	yes	yes	yes	yes
CS formulation	yes	no	yes	no
Mobile and web apps for citizen science	yes	yes	yes	yes
Portal for Open Science	yes	yes	yes	yes
Availability of National funding scheme for CS	yes	no	yes	no
Recognition of the value of citizen science at the national level	yes	no	yes	no
Citizens' engagement in data collection	yes	yes	yes	yes
Citizens' engagement in data visualisation (depends on the initiative - when it's possible)	yes	yes	yes	yes
Citizens' engagement in policy making (depends on the initiative - when it's possible)	yes	no	yes	no
Societal desire to participate more actively in knowledge production, assessment, and decision-making	yes	no	yes	no
Availability of CS-related documents	yes	yes	yes	yes
Availability of CS Policy-related documents	yes	no	yes	no
Availability of Local and Regional SUMP and Environment policy plans	yes	yes	yes	yes

D2.2 Citizen Science Landscape Review showed a big difference in the number of SC initiatives and projects in Eastern (Bulgaria and Greece- limited numbers) and Western (Belgium and Germany – a large number) European countries. The number of CS projects and initiatives in Bulgaria and Greece is relatively low, five to six times lower than in comparison with Belgium and Germany. The number of European CS projects with Bulgarian and Greek participation is growing and is gaining momentum in the country. However, citizen science appears rarely as a project context.

Eurobarometer conducted a survey in 2021 on 'European citizens' knowledge and attitudes towards science and technology'. The survey covered 27 EU Member States + 11 other countries or territories and results reveal a high level of interest in science and technology.

Only 5% of the citizens in Greece actively participate in scientific projects and provide personal data. For comparison, the average level of interest in the EU is 19% for data providing and 12% for participating.

The level of interest in Bulgaria is around 20% less than the average level for the EU. Only 4% of the citizens actively participate in scientific projects and provide personal data. For comparison, the average level of interest in the EU is 19% for data providing and 12% for participating. 41% of the citizens have never been engaged with science and technology.

The survey shows that 80% of citizens in Belgium are engaged with science and technology. The level of interest in Belgium is around 20% higher than the average level for the EU. The citizens actively participate in scientific (21%) projects and provide personal data (39%). The level of interest is almost double the average level in the EU. Only 5% of the citizens have never been engaged with science and technology.

In Germany, the level of interest is around 10% higher than the average level for the EU. The survey shows that 72% of citizens in Germany are engaged in science and technology. The citizens more actively participate in scientific (11%) projects and provide personal data (21%), and the level of interest is almost the same as the average for the EU. Only 11% of the citizens have never been engaged with science and technology.

The language also could be a significant barrier. In non-English countries (such as Bulgaria and Greece) language is a significant barrier to participating in international projects. The researchers are fluent in several languages, at least their native language and English. For the citizens of Bulgaria and Greece, it is hard to understand and communicate in other languages (English for example).

The role of CS in research and innovation is under-appreciated in Bulgaria and Greece - the – real science can come only from the academic sector (universities, academy of science). The biggest part of the CS projects in Bulgaria and Greece is focused on biodiversity. The common understanding is that citizens are skilled enough to map or count, data collection and observation (bird watching, mapping of alien species, etc.) but they are not involved in the process of data analysis. A positive trend is however found in the wide participation of schools from both countries in different SC projects.

Citizen Science based on environmental monitoring has become popular in many countries, but implementing CS projects in Eastern European countries is often challenging due to their socio-political transition histories, low social capital, and relatively short traditions of civic participation. CS in Eastern Europe has received little academic interest. This explains why the power of CS in Greece and Bulgaria is not as well recognized as in Belgium or Germany.

A tool for facilitating rising the numbers of CS projects and initiatives is a creation of CS networks. The networking creates connections between different stakeholders involved in CS and facilitate the collaboration. In Belgium and Germany such networks were established and the recommendation is for strengthening the networking. For Bulgaria and Greece, the recommendation is to start creation of CS networks and to strengthen the networking opportunities. Within the framework of the COMPAIR project, it is planned to organise various events - seminars, workshops, etc., which are a prerequisite for the creation of such networks.

The CS projects in Bulgaria and Greece offer some platforms for sharing data and visualisation. But both countries miss a platform on a national level for sharing data and information regarding CS projects and initiatives. In Germany operates Bürger Schaffen Wissen (“Citizens Create Knowledge”) platform. In Belgium, two platforms: Scivil - the

knowledge centre for citizen science in Flanders (Belgium) and Iedereen Wetenschapper (“Everyone Scientist”), provide information on CS initiatives.

A lot of CS projects offer some kind of platform for data collection and visualisation. A lot of mobile apps, low-cost sensors, games, tools for data collection, processing and visualisation, guidelines and tools exist in different locations. In Greece and Bulgaria such platforms do not exist at the moment. The Aristotle University of Thessaloniki aims to set up a Citizen Science Hub. There is no similar information for Bulgaria. In Belgium and Germany national platforms already exist, which present, connect and support various CS projects and try to collect on one place available resources. The recommendations to Belgium and Germany are to continue collecting such information and to encourage and enhance its sharing. For Bulgaria and Greece – to advocate for creation of national CS platforms. Within the framework of the COMPAIR project, it is planned to organise various events - seminars, workshops, capacity buildings etc., which are a starting point for preparing the creation of such platforms.

A pan-European research information system called OpenAIRE offers tools for finding, storing, linking, and analysing research output from all fields. By launching the OpenAIRE site, it was made feasible to publicly display and fully record EU-funded projects' academic output for the first time. The pilot countries are members of OpenAIRE. Since 2020 Bulgaria is a fully functional Bulgarian Portal for Open Science (BPOS) and a national repository for open access to scientific information, maintained by the National Centre for Information and Documentation (NACID). OpenAIRE National Open Access Desk (NOAD) in Greece provides guidance and support to researchers in receipt of Horizon 2020 funding as well as to all other interested parties like policymakers interested in adopting OS/OA policies, repository managers about compatibility with OpenAIRE guidelines and making their content more visible, research funders on content aggregation and monitoring of results. The Brussels Declaration on Open Access makes Open Access the default in circulating the results of Belgian academic and scientific research. Belgium is also a member of OpenAIRE. The Federal Ministry of Education and Research in Germany released its Open Access Strategy entitled "Open Access in Germany", which contains a clear commitment to the principles of open access and open science and also is a member of the OpenAIRE network. The OpenAIRE portals in Bulgaria and Greece are the only platform for science at the national level.

The Green Paper Citizen Science Strategy 2020 for Germany frames the term “citizen science”. The European Citizen Science Association set out some of the key principles of citizen science. In Belgium, the Citizen Science Roadmap for Local Government frames the term “citizen science”. In Bulgaria and Greece, the term is not defined.

The European Citizen Science Association prepared document 10 Principles of Citizen Science offers governments, decision-makers, researchers, and project leaders a common set of fundamental guidelines to take into account when funding, developing, or evaluating citizen science projects at a time when the field is rapidly growing but has not yet been mainstreamed within traditional research or policy processes. The document is not yet translated into Bulgarian language. The document should be translated into Bulgarian. All the pilot countries should widely disseminate the document. This can be done through the COMPAIR project website (internal pages dedicated to each pilot area), partner websites and profile pages in social media. The 10 Principles of Citizen Science can be included in a project/

partner's newsletters or sent to the authorities, NGO, research and civil organisations via email.

Thanks to the implemented CS projects in all four countries, mobile and web apps for citizen science exist.

Financing is a crucial factor for successful project implementation. The EU ensured targeted funding for the EU funding for the CS projects. In Belgium and Germany exist national funding schemes for CS projects and initiatives, while in Bulgaria and Greece, they do not exist. The national funding mainstreams citizen science and shows the political will to support such initiatives. The national funding is needed to support the inclusion of citizen science in the official science system, to keep the citizen scientist engaged and will facilitate the adoption of citizen science as a scientific method.

The value of citizen science is well recognized at the national level in Belgium and Germany, as evidenced by national funding schemes and platforms, but in Bulgaria and Greece is not recognized.

Almost all CS projects in the pilot countries engaged the citizens in data collection and visualisation. But only the projects in Germany and Belgium have engaged them in policymaking. A major challenge is that data users (such as environmental agencies and authorities) are sometimes sceptical about the quality of the data collected by citizens. The scientific/ research organisations have a potential to prepare tools and methods for quality assurance. If the citizens follow the rules, then data could be reliable and institutions can use them. The COMPAIR project offers methods for data verification and this example can be used as a good practice by pilot areas.

The societal desire to participate more actively in knowledge production, assessment, and decision-making process in Belgium and Germany is more clearly defined than in Bulgaria and Greece. It corresponds to a bigger number of CS projects and participants. The creation of CS coordination centres in research organisations together with local/regional/ national authorities and civil organisations can facilitate the participation. The centres will support the co- creation process. The citizens are powerful instrument for data collection. The scientist can create a guidelines, tools and instrument for data collection to ensure data quality. Then the environmental agencies can recognize data collected by citizens as trusted data. The policymakers can use this trusted data for policymaking. The COMPAIR project offers a unique opportunity combining measurements of traffic intensity and air quality with methods for data validation and data sharing and visualisation through project dashboards. In Belgium and Germany such centres exist and recommendation is to strengthen their activity. For Bulgaria and Greece – to follow the examples and take advantage of the opportunity networking and cooperation during the COMPAIR project events.

Organisation of the CS events at National level can bring together civil organisations, research organisations, policymakers and funding bodies. The importance of personal communication should not be underestimated. Such conferences are organised in Belgium and Germany, but there is no data for Bulgaria and Greece. The European Citizen Science Association is a consortium member of the COMPAIR project and could give significant support for preparation and organisation of such events.

In the four pilot countries, CS-related documents are available. The documents were produced during the implementation of the CS project in the pilot countries. But only in Belgium and Germany policy documents on CS were found.

In four pilot areas local/ regional plans for sustainable urban mobility and environmental policy plans were found.

5.1. Policy landscape review – Athens, Greece

5.1.1. Citizen science projects

The analysis of the SC projects and initiatives in Greece (D2.2) mapped 20 samples. Most of them are at the country level (domestic initiatives), EU funded and dedicated to biodiversity and air quality.

Table 7: CS projects in Greece

Field	Projects	Total	Participation and engagement
Air quality monitoring	hackAIR, Cos4Cloud, URwatair	3	Citizens are involved in data collection in almost all of the listed projects.
			Regarding data analysis - most of the projects offer some kind of platform for data access or visualisation and not data analysis.
			Regarding participation in the decision-making process - there is no possibility for the citizens to participate in the policymaking process
Biodiversity monitoring	Sharks and Rays in Greece and Cyprus, Hellenic Fauna CS Project, eBird, "Is it Alien to you...Share it!", Alientoma, Biodiversity GR, CrabWatch, iNaturalist	8	All projects involve citizens as part of the data collection process and offer training/ workshops/meetings with citizens.

Field	Projects	Total	Participation and engagement
			In terms of decision-making, the collected data from some of the projects are available on a project website or platform for all stakeholders. The projects are led by academic organisations and data were mostly used for scientific purposes, not for the policymaking
Monitoring of soil quality, environmental conditions, urban waste, water and odour pollution, and seismic activity	Scent, DNOSES, Waste4Think, GROW, GLOBE, Hackquake	6	<p>Citizens are involved in the data collection process, for mapping and visualisation on different platforms.</p> <p>In terms of contributing to decision-making processes - the citizens map and frames different environmental problems and share the information through specific websites/ platforms and policymakers can focus their attention on how to solve the problems</p>
Other	INCENTIVE	1	<p>The project aims to demonstrate the potential of citizen science through the co-creation, establishment and assessment of Citizen Science Hubs</p> <p>The Hub will also support participatory practices between academia and civil society, facilitate the development of new competencies and skills, and finally ensure improved transfer of knowledge and technology.</p>

The financing of the projects is mostly EU funding. There isn't a national financing scheme for CS projects and initiatives.

In the field of air quality, the participants are mostly school children. They are engaged with data collection and visualisation on a platform and there is no possibility for participation in a decision-making process.

The participants in biodiversity projects are volunteers who capture and document species on a platform. The data were used for scientific research, not for policy formulation.

The citizens engaged in projects for Monitoring soil quality, environmental conditions, urban waste, water and odour pollution, and seismic activity collected and shared data on websites or platforms. They can map and frame different environmental problems and share the information and policymakers can focus their attention on how to solve the problems. It's unclear whether decision-makers use this data in policymaking.

In the frame of the project INCENTIVE the Aristotle University of Thessaloniki will create a Citizen Science Hub. The Hub will offer opportunities and resources for learning, research, and innovation, as well as raise awareness on how CS benefits science, society, the economy, and the environment. The Hub will also support participatory practices between academia and civil society, facilitate the development of new competencies and skills, and finally ensure improved transfer of knowledge and technology. At the moment, the participation of policymakers is not foreseen.

The participants in the CS projects are engaged through training, workshops, and networking basically on how to collect and share data. The leading partners in the projects were universities and non-governmental organisations. No public authority-led project has been found.

The citizens are engaged in data collection, mapping, and data visualisation on different project platforms. They can develop new competence and skills but can't participate directly in the policymaking process. Collected data were mostly used for scientific purposes. The data platforms offer opportunities for policymakers to focus their attention on how to solve the problems.

Some of the projects developed platforms for data sharing and visualisation. But there isn't a national platform dedicated to SC projects and initiatives.

5.1.2. Citizen science-related policy documents

A. Introduction

CS in Greece is still at a premature level in comparison to other countries as a result of the number and the extent of the relevant activities. The majority of CS-related ongoing or recently finished projects refer to STEM activities. Out of those activities, biodiversity surfaced as the main research subject, while air quality, urban environment, and agriculture seem to be high in the research preferences. Regarding the non-STEM activities, education is the domain with the most significant influence in citizen science projects.

B. CS Policy-related documents

Following desk research in Greece, no documents were found in which CS was considered in the context of a strategy or plan. The study found strategic documents containing measures related to citizens' involvement (Table 2).

Table 8: Policy related documents in Greece

Name of the document	Document type	Source of information
Athens Resilience City through NCCF funding	Program	Municipality of Athens
National Recovery and Resilience Plan	Plan	Ministry of Finance, Recovery and Resilience Facility Agency
National Law for Sustainable Urban Mobility Plan in Greece	Law	Ministry of Infrastructure and Transport

The city of Athens launched a funding program as an evolution of the Athens Resilience Strategy for Climate Change Adaptation and Mitigation 2030. The funding includes actions in Athens and specifically in 4 central areas. The plan also included a co-creational approach involving citizens through public consultations and surveys.

The National Recovery and Resilience Plan (NRRP) “Greece 2.0”, Component 3.4. “Increase access to effective and inclusive social policies” integrates the dimension of digital transformation through action regarding the integration of Technology and Science with STEM programs (Science, Technology, Engineering, and Mathematics) in the Centers for Creative Employment. These programs will be designed to be suitable for children from twelve to fifteen years old and support the parallel enhancement of children's digital skills.

National Law for Sustainable Urban Mobility Plan (SUMP) in Greece - includes the laws and articles for implementing SUMP in Greek cities and measures for citizen involvement and participation in co-creation.

Many projects implemented in Greece are in the field of biodiversity. This good practice for interaction between citizens and academia should also be used in the field of air quality and sustainable mobility.

25 % of people in Greece believed that research and innovation will affect the fight against climate change and 20% - protection of the environment. This potential should be used and developed to a more mature stage targeted to the CS.

The National Recovery and Resilience Plan is a good opportunity to start with early education in the schools and the involvement of the students and their parents in SC.

After analysis of the result from the implementation of the CS project in Greece were found documents that can be used as a guideline for the wide promotion of CS and citizens engagement.

Table 9: CS documents

Project name	Description of the document	Document
Biodiversity GR	The HBC is intended to promote citizens participation in science and to the documentation of biodiversity projects	https://www.biodiversitygr.org/research-papers.html
CitizenHeritage	Exploring the role of Higher Education Institutions (HEI) as incubators of the next generation open science citizens, in terms of staff and student skills, curricula and interdisciplinarity, and as institutions situated in a broader social context where citizens advocate a more important role in decision taking in modern societies with active citizenship, civic engagement, bottom-up public intervention, unlocking the still unused potential in connecting the user engagement generated through civic participation with the open science cycle.	Review of practices of Higher Education engagement in citizen enhanced open science in the area of cultural heritage
	Improving methodologies of co-creation and user engagement with cultural heritage with better alignment within the educational context, also making students in Cultural Studies and Humanities closer to Cultural Heritage Institutions, thus lowering the threshold between the university and the later employment field.	Methodology, user requirements and guidelines for Cultural Heritage Institutions and Universities
Cos4Cloud	The guide presents results from the experience and lessons learned in co-designing thirteen technological services within the Cos4Cloud project. The technological services were created from a bottom-up approach, following a co-design process connected to an agile software development methodology. The result of implementing the co-design framework and methodologies and the corresponding monitoring during the co-design of the services, were evaluated and adapted to be shared with the citizen science community as a methodological guide.	Co-design as a service: Methodological guide
Dnoses	The Green Paper on Odour Pollution is a policy document that aims to place odour pollution in the policy agendas by providing recommendations to better tackle the issue and move towards an improved regulatory framework in Europe	Green Paper on Odour Pollution

Project name	Description of the document	Document
	<p>These guidelines aim to support citizen science projects operating in odour-conflicted communities. They are DIY guidelines – helping you to ‘do it yourself’ – and offer tested tools and practical tips for running projects and adapting them to different contexts</p>	<p>DIY guidelines for citizen science projects in odour-conflicted communities</p>
<p>eBird GR</p>	<p>eBird transforms the global birding community's passion for birds into a powerful resource for research, conservation, and education.</p>	<p>https://science.ebird.org/en/research-and-conservation/publications?_gl=1%2ay540fx%2a_ga%2aMTEyMjUzNzg4OS4xNjc5Mzg2NzM3%2a_ga_QR4NVXZ8BM%2aMTY3OTM4Njc5Ny4xLjEuMTY3OTM4NjgwMC41OC4wLjA.&_ga=2.225643674.1483091616.1679386737-1122537889.1679386737</p>
<p>GLOBE</p>	<p>Since 1994, the Global Learning and Observations to Benefit the Environment (GLOBE) Program has been providing students and the public worldwide with the opportunity to meaningfully contribute to understanding of the Earth system and global environment. As an international science and education program, GLOBE is dedicated to supplying the science, technology, engineering and mathematics (STEM) professionals of tomorrow with the scientific knowledge necessary to tackle Earth's biggest mysteries. The mission is to increase awareness of individuals throughout the world about the global environment, contribute to increased scientific understanding of the Earth and support improved student achievement in science and mathematics.</p>	<p>https://www.globe.gov/documents/10157/69578719/GLOBE+Strategic+Plan+2018.pdf/e9e09c09-2f98-94c1-be03-e8adddd13f02?t=1627588726243</p>
<p>hackAIR</p>	<p>hackAIR aims to raise collective awareness about the daily conditions of air quality and thermal comfort, as well as provide information about the probability of forest fires in Europe. It enables easy access to information relevant to outdoor air pollution and thermal comfort conditions, and also contributes to their monitoring by stating the perception about them. In addition, hackAIR informs on the probability of a forest fire in an area.</p>	<p>https://www.hackair.eu/wp-content/uploads/2019/01/d7.5-pilot_implementation_report.pdf</p>
<p>Hackquake</p>	<p>OpenAIRE was established in 2018 to ensure a permanent presence and structure for a European-wide national policy and open scholarly communication infrastructure. OpenAIRE is a Non-Profit Partnership (NPP) incorporated under the provisions of Greek Law (articles 741 onwards of the Greek Civil Code) and Law No 4072/2012.</p>	<p>https://www.openaire.eu/openaire-strategy-2023-25</p>

Project name	Description of the document	Document
INCENTIVE	INCENTIVE is a cross-national 3-year long Coordination and Support Action (01/02/2021-31/01/2024), supported by the European Union within the framework of the Horizon 2020 programme. It aims to demonstrate the potential of citizen science through the co-creation, establishment and assessment of Citizen Science Hubs (CSH) in four European Universities:	https://incentive-project.eu/wp-content/uploads/2022/08/D2.5-Methodological-Guide-and-Toolkit-for-setting-up-Citizen-Science-Hubs.pdf
Scent	Scent is a European Union research project funded under the Horizon 2020 programme. The project runs between 2016 and 2019 and comprises 10 partner organisations across 6 countries. Europe has the capacity and potential to lead a global citizen movement aimed at land use monitoring through a people-centred observation web. Scent will be this movement. Scent will engage citizens in environmental monitoring and enable them to become the ‘eyes’ of the policy makers. In doing so citizens will support the monitoring of land-cover/use changes using their smartphones and tablets. The project will demonstrate the huge potential of citizen observation and monitoring of the environment. A people-led online observation movement will capture land-cover use and changes through user-friendly tools and technologies, The Scent Toolbox. This will complement existing forms of monitoring such as satellite and remote sensing which are costly and less dynamic.	https://scent-project.eu/publications
Sharks and Rays	The M.E.C.O. (Mediterranean Elasmobranchs Citizen Observations), is a Mediterranean initiative, which aims to create a network of Mediterranean elasmobranch sightings data, through a collaboration between different teams in various countries, to better understand the occurrence, seasonality and distribution of elasmobranchs in this region.	https://isea.com.gr/informative-material/alien-species/?lang=en
URwatair	URwatair is a citizen science project for urban air quality and rain water management, coordinated by the Society for the Environment and Cultural Heritage - Thessaloniki Branch, and scientifically supported and materialised by the Faculty of Engineering, Environmental Informatics Research Group and Hydraulics Division (Schools of Mechanical Engineering and Civil Engineering, respectively), Aristotle University, Thessaloniki, Greece	https://www.researchgate.net/publication/355889929_A_Citizen_Science_Approach_for_Indoor_Air_Quality_in_Thessaloniki_Greece

The documents aim to demonstrate the huge potential of citizen observation and monitoring of the environment, recommendations to support the CS activities, and encourage wide citizens participation via guidelines and tools.

All the projects are single initiatives without connection between them. There is a lack of civil participation. In the common case universities are the lead organisation and play a significant role. They have a potential to overcome the gap between level of ambition and real citizens' participation in the projects.

C. Study of CS in Local and Regional Sustainable Urban Mobility Plans (SUMP) and Environment policy plans

The analysis of strategic documents related to air quality and sustainable transport in Athens and how they fit to the CS is shown in Table3. The columns correspond to the questions within the methodological framework.

Table 10: CS in SUMP and Environment policy plans

Name of the document (including hyperlink)	1 CS covered	2. Citizen involvement	3. Co-creation / co-design	4. Citizen data collection	5. Citizen evaluation
Athens Resilience Strategy for 2030		X	X	X	
Athens Resilience City (NCFF) - Area of Akadimia Platonos		X	X		
Athens Resilience City (NCFF) - Area of Lycabettus Hill		X	X		
Athens Resilience City (NCFF) - Area of Lamprini		X	X		
Athens Resilience City (NCFF) - Area of Exarcheia		X	X		
National Law for Sustainable Urban Mobility Plan in Greece		X	X		
City of Athens SUMP 2nd implementation		X	X		

Athens Resilience Strategy for 2030 mapping the current landscape in Athens and foresees 65 actions and 53 supporting actions, framed in 4 pillars. Namely, transform Athens into an open, vibrant, green, and proactive city.

Athens Resilience City (NCFF) - Area of Akadimia Platonos -provides technical and financial support funding for implementing the Athens Resilience Strategy Program. The implementation foresees interventions in Akadimia Platonos, namely urban landscape re-

construction, green infrastructure, water management, traffic management and mobility, climate-related interventions, etc.

Athens Resilience City (NCFF) - Area of Lycabettus Hill - provides technical and financial support for implementing the Program of the Athens Resilience Strategy implementation foresees interventions in the area of Lycabettus Hill, namely green interventions, water management, blue growth, etc.

Athens Resilience City (NCFF) - Area of Lamprini - provides technical and financial support for implementing the Program of the Athens Resilience Strategy implementation foreseeing interventions in the area of Lamprini, namely urban landscape re-construction, green infrastructure, water management, climate-related interventions, etc.

Athens Resilience City (NCFF) - Area of Exarcheia - provides technical and financial support for the implementation of the Program of the Athens Resilience Strategy implementation foresees interventions in the area of Exarcheia, namely urban landscape re-construction, green infrastructure, water management, traffic management and mobility, climate-related interventions, etc.

The measures in AQ/SUMP are mainly dedicated to the citizen's involvement and co-creation. The Athens Resilience Strategy encourages citizens to participate in data collection. The citizens can contribute significantly to environmental monitoring and influence community behaviour.

There are a small number of standardised air quality monitoring stations in cities. They are not able to present a complete picture of local air quality. By using air quality sensors, citizens can use air sensors to understand the origins of pollution better. Even if the data from the sensors are not of the same high quality as those from the AQ stations, they can draw the attention of local authorities to a specific problem in a given area of the city. Once the problem has been identified, local authorities can use standard measurement methods to implement measures and policies to improve air quality.

The policymakers could give more power to citizens to participate in co-designing local, sustainable policies. Adopting new policies could be increased if solutions proposed by local active citizens and organisations are used.

5.2. Policy landscape review – Berlin, Germany

5.2.1. Citizen science projects

Germany is one of the European countries with a large number of citizen science projects and activities.

On the German platform, [Burger Schaffen Wissen](#) (“Citizens Create Knowledge”) around 100 projects were listed for Berlin alone and over 150 for Germany. For the project, almost 30 initiatives have been studied in detail.

Table 11: CS projects in Germany

Field	Projects	Total	Participation and engagement
Air quality and traffic monitoring	hackAIR, Measuring the Berlin Air, SenseBox, HEAL, BerlinAIR NO2 Atlas, Sensor.Community, PolDiv, Envirocar	8	<p>Citizens are involved in data collection in almost all of the listed projects.</p> <p>Regarding data analysis, most of the projects offer some kind of platform for data access or visualisation. So emphasis is mostly placed on that, and not on analysing data together with citizens. Local workshops exist as part of sensor.community, but they seem to be for sensor building mostly and not data analysis. EnviroCar, on the other hand, offers data analysis services, while hackAir had a final workshop where participants briefly looked at the project's platform and discussed collected data.</p> <p>Regarding participation in the decision-making process, only hackAir offered a general plan to involve citizens and policymakers in a policy dialogue. Unclear what came of it.</p>
Biodiversity monitoring	Fledermausforscher in Berlin, Stadtwild Tiere Berlin, InsktenMobil, Muckenatlas, NaturGucker, My Ocean Sampling Day, Ornitho, Tauchen für Naturschutz,	9	<p>All projects involve citizens as part of the data collection process, but most of them don't offer any comprehensive data analysis workshop/meeting with citizens. An exception is the project Tauchen für den Naturschutz, where divers discuss collected results in groups after each dive.</p>

Field	Projects	Total	Participation and engagement
	ArtenFinder		In terms of decision-making, the database of the project Mückenatlas is open to political stakeholders to facilitate risk assessments, although no direct policy dialogues were observed. In Tauchen für den Naturschutz, the idea of nature-conservation diving was proposed for implementation in the Mecklenburg Lake District.
Water quality monitoring	Plastik Pirates, Citiclops, FLOW, BeachExplorer	4	Citizens involved in the data collection process, sometimes also beyond. Two projects a) offered a conference to analyse the results together with volunteers (Project FLOW) and b) fully or partially delegated the management of local CS activities to the community (Project citiclops). All projects also provide results on an online data platform.
			In terms of contributing to decision-making processes, water body data is incorporated into ecotoxicological and ecological studies to serve as a basis for local and regional strategies for water protection as part of the FLOW project.
Environmental and atmospheric monitoring	GLOBE, Tater Gewasser, Netatmo CWS, PV2Go	4	Citizens involved in the data collection process, not beyond. Projects provide results on an online data platform.
Monitoring of odour pollution and soil quality	DNOSES, Open Soil Atlas	2	Citizens involved in the data collection process and data analysis. DNOSES issued a policy brief and a governance roadmap, but it is unclear whether it has impacted decision-making in any form. Open Soil Atlas aims to empower citizens with gathered knowledge to exert pressure on local policymakers.
Others	Bürger Schaffen Wissen, SimRa	2	Citizens are collecting data as part of SimRa. The project plans to influence changes in traffic signalling plans so that cycling can become safer and more attractive

Field	Projects	Total	Participation and engagement
			for city residents.
			<p>Bürger schaffen is the largest platform in Germany for citizen science projects. Although not a project itself, it offers lots of workshops and assistance in establishing projects. As such, it doesn't really offer data analysis workshops (these depend on individual projects) but it is trying to establish a link to local decision makers.</p>

The financing of the projects is a mix between EU and national funding. The national funding scheme is an important tool that guarantees the sustainability of the future development of CS projects and initiatives in Germany.

The leading partners in the projects were universities and non-governmental organisations and one initiative was led by the Federal Ministry of Education and Research.

The citizens are involved mostly in data collection. Some of the projects have a platform for sharing data with free access. Citizens, decision-makers and scientists could analyse data.

In the field of Air quality and traffic monitoring, only hackAir offered a general plan to involve citizens and policymakers in policy dialogue but stands unclear what came of it.

In the field of Biodiversity monitoring the citizens are involved in data collection. Some of the projects offer citizens training. Sometimes the local authorities are involved in project implementation, but the real policy dialogues were not observed.

In the field of Water quality, monitoring the citizens are involved in data collection and have the possibility to analyse the results together with the scientists during common events. The authority, responsible for water quality is involved, because they prepared a strategy for water protection. The projects offer the possibility for data sharing by platform.

Citizens who participated in Environmental and atmospheric monitoring are engaged only with data collection and visualisation on the platform.

Citizens participated in the monitoring of odour pollution and soil quality involved in the data

collection process and data analysis. As a result of DNOSES project implementation a policy brief and a governance roadmap were issued, but it is unclear whether it has impacted decision-making in any form.

Bürger schaffen Wissen (citizens create knowledge) is the central platform for citizen science in Germany. The platform has presented, connects and supports Citizen Science projects since November 2013. Its main purpose is to give an overview of citizen science projects to illustrate the concept of citizen science, to further develop the landscape of citizen science and increase its visibility within the German public and discourse. The platform was funded by the German Ministry of Education and Research.

5.2.2. Citizen science-related policy documents

A. Introduction

The most important network for CS in Germany has been established in the context of the Citizens Create Knowledge platform - Bürger schaffen Wissen with the primary goal to present, connect and support CS in Germany. In addition, the platform offers various services related to Citizen Science, such as the organisation of the CS Forum and other events, communication through different social media formats, and advice and support for CS projects to strengthen citizen research sustainably.

B. CS Policy-related documents

The desk research in Germany found several documents in which CS was considered in the context of a strategy or plan.

Table 12: Policy related documents in Germany

Name of the document	Document type	Source of information
Green Paper Citizen Science Strategy 2020 for Germany	strategy	Platform "EU-Citizen.science"
White Paper Citizen Science- Strategy 2030 for Germany	strategy	Platform "Citizens Create Knowledge"
German Recovery and resilience plan (Component 3.1 - Digitalisation of education)	plan	Federal Ministry of Finance

Green Paper Citizen Science Strategy 2020 for Germany presents the understanding, the requirements, and the potential of CS, introduces the current role of CS in Germany, identifies pertinent challenges, and recommends a series of actions to foster Citizen Science in the country.

White Paper Citizen Science - Strategy 2030 for Germany is a strategy with practical recommendations that aim to strengthen CS by 2030 to develop its innovative potential for

science, society, and politics in the country. The White Paper identifies 15 key fields of action for citizen science. Each area of activity specifies concrete goals and core approaches on how citizen science in Germany can contribute to essential goals in politics, society, and science and how these can be anchored more intensively by 2030.

German Recovery and resilience plan (Component 3.1 - Digitalisation of education) - the Federal Government adopted the Digital Pact for Schools that supports the federal states and municipalities in investing in digital education infrastructure. The goals of the Digital Pact are the nationwide development of a modern digital education infrastructure with educational pedagogy as the top priority. The main goal is to establish modern digital infrastructure in all general and vocational schools in Germany and enable nationwide improvements and access to digital education by 2024.

Germany has a strong political will at all levels and ambition for even greater citizen participation in science. The management of volunteers, an area of action set forth in the White Paper, illustrates this point well. In order to facilitate and strengthen the engagement of citizens, so-called volunteer agencies help connect scientists and citizens interested in implementing or participating in a citizen science project. These agencies offer guidance and education on a particular topic and inspire and accompany people to get involved with their diverse skills, experiences and interests. They also advise facilities, institutions and organisations that would like to work with volunteers, strengthening the link between different actors.

These ambitions have reached the citizens, which is confirmed by the fact that the percentage of citizens who believe that research and innovation will affect health and medical care and fight against climate change is the same (47%) and 30% for the protection of the environment.

After analysis of the result from the implementation of the CS project in Germany were found documents that can be used as a guideline for the wide promotion of CS, citizens engagement and implementation of the CS project.

Table 13: CS documents

Project name	Description of the document	Document
ArtFinder	ArtenFinder Berlin offers laypeople and species experts the opportunity to document their observations of animals, plants and fungi with pinpoint accuracy and share them with the community. Experts then check the plausibility of this data. The checked data are of high quality and can therefore be used for professional nature conservation. A central output is a database with documented findings.	https://arteninfo.net/elearning.html
Bürger Schaffen Wissen	Newsletter dedicated to the Citizen Science in Germany - old and new forms of civic engagement in science	BBE Newsletter No. 20: Citizen Science in Germany

Project name	Description of the document	Document
	Guide to Legal Issues in Citizen Science Projects	Guide to Legal Issues in Citizen Science Projects
	Framework paper for working groups (AG) in cooperation with citizens create knowledge	Framework paper for working groups (AG) in cooperation with citizens create knowledge
Citclops	One of the main objectives in Citclops was to deliver interpreted information to citizens, decision makers and researchers. The deliverable aims to describe the development and implementation of a decision support system (the Citclops Data Explorer)	http://www.100001labs.org/wp-content/uploads/2013/09/Integration-and-implementation-of-Citclops-final-prototype-and-decision-support-system.pdf
Dnoses	The Green Paper on Odour Pollution is a policy document that aims to place odour pollution in the policy agendas by providing recommendations to better tackle the issue and move towards an improved regulatory framework in Europe	Green Paper on Odour Pollution
Dnoses	These guidelines aim to support citizen science projects operating in odour-conflicted communities. They are DIY guidelines – helping you to ‘do it yourself’ – and offer tested tools and practical tips for running projects and adapting them to different contexts	DIY guidelines for citizen science projects in odour-conflicted communities
Envirocar	Citizens were invited to contribute data collected while driving their car to gain information about the actual city traffic situation. The three participating cities successfully completed the tests and these provided valuable insights into the project’s main ideas and research questions.	https://bmdv.bund.de/SharedDocs/DE/Artikel/DG/mfund-projekte/citram.html
Fledermausforscher	Fledermausforscher is part of the wto impact projects funded by the Federal Ministry of Education. The research investigated the influence of the degree of involvement in CS projects on psychological ownership as well as the consequences of ownership for wildlife CS projects and intentions to engage in wildlife conservation.	https://reader.elsevier.com/reader/sd/pii/S2666622720300010?token=98ED6401F9E71FA09CC0247211A68C2E36F4E6E877D4CD8793D33C1CBFC91010853659682720D1DC6F06629F1BD5FD71&originRegion=eu-west-1&originCreation=20230317114425
HackAIR	The recommendations listed in the final report of the hackAIR project are lessons learnt during the implementation of the project. They have been generalised to cover a wide range of citizen science activities and not only those related to air pollution, and are presented as guidelines	https://www.hackair.eu/wp-content/uploads/2019/01/D7.8-Report-on-procedures-followed-and-lessons-learnt.pdf

Project name	Description of the document	Document
HEAL	<p>To raise awareness of air pollution in school environments and how it affects children's health, HEAL developed a citizen science initiative to monitor indoor and outdoor air pollutants around primary schools in Berlin, London, Paris, Madrid, Sofia and Warsaw. The results in Berlin clearly illustrate that indoor air quality is influenced by outdoor air pollution. The concentrations of NO₂ detected in the schools in Berlin have travelled from outdoors into the schools' interior where they can affect the health of the pupils as they spend a significant part of the day there.</p>	<p>https://www.env-health.org/wp-content/uploads/2019/09/Berlin-city-report-Healthy-air-children_EN.pdf</p>
Muckenatlas	<p>The Mückenatlas (Mosquito Atlas) is a citizen science project which went online in April 2012. Citizens are asked to collect mosquitoes in their private surroundings, kill them by freezing and send them to the research institutions involved. The mosquitoes are morphologically or genetically identified to species by experts in entomology who will inform the mosquito hunters' on the species they have sent and provide them with the major biological facts on the collected species. The data suggest that a citizen science project such as the Mueckenatlas may aid in detecting changes in the mosquito fauna and can therefore be used to guide the design of more targeted field surveillance activities.</p>	<p>https://academic.oup.com/jme/article/54/6/1790/4201700?login=false</p>
Open Soil Atlas	<p>Within the project time, 77 datasets were collected by citizen scientists. In a final analysis it was concluded that mostly all sites that are not being actively regenerated show a certain amount of soil degradation. As soil samples were taken only at specific points, they are still not representative of the overall state of soils of Berlin.</p>	<p>https://www.buergerschaffenwissen.de/sites/default/files/assets/projekte/usaer-4879/pdf/OSA%20Final%20Paper%20%28Englisch%29.pdf</p>
Plastik Pirates	<p>The project booklet aims to give young people aged between 10 and 16 hands-on experience of the issues related to seas and the ocean, particularly the problem of plastic waste in seas and flowing waterways. The booklet helps young people find their feet during the excursion and serves as a scientific guide to data collection.</p>	<p>https://www.plastic-pirates.eu/sites/default/files/document/2022-09/Project_Booklet_EN.pdf</p>

Project name	Description of the document	Document
SenseBox	As a user manual, the senseBox flashcards help in experimenting with the senseBox. In addition to the basics of computer science participants will receive important information on how to use the components of the senseBox.	https://sensebox.de/docs/senseBox_Lernkarten_v3_online.pdf

The documents contain methodologies and tools on how to engage the citizens and young people in scientific activities, raising awareness of the air quality issues and how the citizens can contribute to the project goals.

C. Study of CS in Local and Regional Sustainable Urban Mobility Plans (SUMP) and Environment policy plans

The analysis of strategic documents related to air quality and sustainable transport in Berlin and how they fit into the CS is shown in the table below:

Table 14: CS in SUMP and Environment policy plans

Name of the document (including hyperlink)	1 CS covered	2. Citizen involvement	3. Co-creation / co-design	4. Citizen data collection	5. Citizen evaluation
Urban Development Plan Mobility and Transport Berlin 2030 - Documentation of Participation		x			
Integrated Business Transport Concept Berlin 2021		x			
Clean Air Plan for Berlin		x			
Federal Government's Climate Protection Plan 2050		x			
Integrated Environmental Programme 2030		x			
Berlin Energy and Climate Protection Programme (2022 - 2026)		x	x		
Berlin Noise Action Plan 2019 - 2023		x	x		

Urban Development Plan Mobility and Transport Berlin 2030 is a part of The Berlin Strategy - Urban Development Concept Berlin 2030. The plan sets forth a vision for future urban transport and aims to transform it into concrete goals. The plan addresses thematic or spatial strategies and measures to achieve these aims. Citizens had the opportunity to contribute their competences, experiences and everyday knowledge on future-related issues and express their concerns and wishes. People with different characteristics entered a dialogue and introduced their different life-world perspectives.

The Integrated Business Transport Concept Berlin 2021 is a planning basis and support for economic transport. It defines goals and actions while considering competing requirements between different stakeholders. The economic transport stakeholders agree on a guideline for infrastructure requirements. This guideline contains measures for constructing, replacing and maintaining infrastructures relevant to commercial transport.

The Clean Air Plan for Berlin is a plan of measures for sustainable air improvement in Berlin. In its development, citizens, associations, chambers and authorities were involved via specialist events and online surveys.

The Federal Government's Climate Protection Plan 2050 is the central instrument for achieving the national climate protection targets by 2050, it provides orientation and shapes the roadmap towards a climate-neutral economy. The citizens' dialogue was established as the second pillar in the participation process. The participation process led to the catalogue of measures for the Climate Protection Plan 2050.

The Integrated Environmental Programme 2030 intends to provide future environmental policy orientation. Central to this is the change towards a social-ecological market economy and a sustainable society. During a citizens' dialogue, various recommendations for action were made based on answers to the question: Ecologically sustainable: How do we want to live, do business and work in 2030? How can we get there together?

The Berlin Energy and Climate Protection Programme (2022 - 2026) is a key instrument for achieving Berlin's climate targets. According to the requirements of the Berlin Energy Transition Act, the programme shall be regularly updated with the involvement of citizens. In addition to expert forums, workshops and public events, two phases of online participation were planned for citizens, in which suggestions and tips for further development as well as concrete measures can be submitted and evaluated. Workshop rounds covered the areas of buildings and urban development, transport, economy and energy, focusing on the identification and development of measures.

The Noise Action Plan 2019 - 2023 defines action and measures that will be developed and implemented in the coming years, including future mobility in new urban neighbourhoods, a 30 km/h speed limit policy, quiet areas and urban recreation areas, as well as road traffic behaviour. Around 1300 participants provided information on noise locations and suggested measures for noise reduction during an online participation event. At a "noise forum", different stakeholders, including interest groups representing civil society, had the opportunity to get informed about and give their advice for the Noise Action Plan.

Berlin's citizens are actively involved in the policymaking process. Politicians take the needs and desires of citizens into account.

The network for CS Bürger schaffen Wissen presents, connects and supports CS in Germany. The platform raises awareness among the citizens of the CS achievements and allows them to participate in CS-related projects.

This is an excellent example of collaboration between policymakers, scientists and citizens. The citizens could be more involved in the data collection and evaluation process.

5.3. Policy landscape review – Flanders, Belgium

5.3.1. Citizen science projects

In Belgium, two platforms: [Scivil](#) - the knowledge centre for citizen science in Flanders (Belgium) and [Iedereen Wetenschapper](#) (“Everyone Scientist”), provide information on more than 180 CS initiatives. More than 30 relevant initiatives for COMPAIR have been scrutinised.

Table 15: CS projects in Belgium

Field	Projects	Total	Participation and engagement
Air quality and traffic monitoring	AIRbezen, iSCAPE, Curieuze Neuzen 2016, Curieuze Neuzen 2018, Leuvenair, HASSELair, Meet Mee Mechelen, hackAIR, CurieuzenAir, Luchtpijp, InfluenAir, ExpAIR, WeCount, BikeSTEM for Schools	14	Citizens are involved in data collection in almost all of the listed projects.
			Regarding data analysis, most of the projects offer some kind of platform for data access or visualisation. For the citizens were organised workshops and training on how to assemble the devices and how to collect data.
			Regarding participation in the decision-making process, the main objective of the projects is to inform the citizens about AQ. The projects CurieuzenAir and ExpAIR were led by policymakers. Even more - CurieuzenAir is the largest citizen science project on air quality ever carried out in Brussels. Thousand citizens mapped the air quality levels across the Brussels-Capital Region with professional guidance by scientists.
Biodiversity monitoring	Snapp nature, Bugs 2 the Rescue, TriAS, Animals Under Wheels, My Gardenlab	5	All projects involve citizens as part of the data collection, mapping and sharing on the platforms

Field	Projects	Total	Participation and engagement
			In terms of decision-making, the project databases, in common cases, are open to political stakeholders to facilitate risk assessments and future policies. Animals Under Wheels project identifying and mitigating roadkill hotspots. Belgium has developed decision support tools to inform invasive alien species (IAS) policy, including information systems, early warning initiatives and risk assessment protocols. The TriAS project brings together 21 different stakeholder organisations and will be used as a tool for improvement of the IAS policy.
Monitoring of atmospheric conditions, water and soil quality, odour and noise pollution	Butterfly, Stiemerlab, Curieuzeneuzen in de Tuin, Omniscientis, NoiseTube	5	Citizens are involved in the data collection process, sometimes also beyond. The Butterfly project involved pupils, teachers, and parents in the whole process: installing the station, gathering and analysing data, presenting results. The on-line map of soils developed in the Curieuzeneuzen in de Tuin project can be used for improving agricultural policy.
Social sciences, humanities and arts	SOS Antwerpen, MamaMito, Citizen's talk, CitizenHeritage	4	Citizens involved in the data collection process together with the scientists.
Other	Scivil, Iedereen Wetenschapper, AstroSounds	3	Citizens are collecting data as part of SimRa. The project plans to influence changes in traffic signalling plans so that cycling can become safer and more attractive for city residents.
			Scivil is one of the platforms in Belgium for citizen science projects. Although not a project itself, it offers lots of workshops and assistance in establishing projects, tools and methods for data collection and trying to establish a link to local decision-makers.

The CS initiatives in Belgium included European initiatives, EU-funded projects, and activities started by local and regional authorities.

The leading partners in the projects were universities and some policymakers. The Flemish institute for technological research (VITO) is part of the policy domain of the Department of Economy, Science & Innovation of the Flemish government and led the project Meet Mee Mechelen.

The projects in the field of Air quality and traffic monitoring engaged citizens in data collection and visualisation. Some of them offer training to the citizens on how to assemble the devices

and share data on a platform. The policymakers are involved in project implementation. The projects CurieuzenAir and ExpAIR were led by policymakers. The CurieuzenAir is the largest citizen science project on air quality ever carried out in Brussels; a thousand citizens map the air quality levels across the Brussels-Capital Region with professional guidance by scientists.

The projects in the field of Biodiversity monitoring engaged citizens in data collection, mapping and sharing on the platform. Based on collected data Belgium has developed decision support tools to inform invasive alien species (IAS) policy, including information systems, early warning initiatives and risk assessment protocols. The results from the implementation of TrIAS project will be used as a tool for the improvement of the IAS policy.

The projects dedicated to Monitoring atmospheric conditions, water and soil quality, odour and noise pollution engaged citizens in data collection. The Butterfly project involved pupils, teachers, and parents in the whole process: installing the station, gathering and analysing data, and presenting results. The online map of soils developed in the Curieuzeneuzen in de Tuin project will support policymakers to improve agricultural policy.

The projects in the field of Social sciences, humanities and arts involved citizens in the data collection process together with the scientists.

Scivil is the knowledge centre for Citizen Science in Flanders. Scivil was founded with funding from the Flemish government (department of Economy, Science and Innovation) to unite, support and inform scientists, citizens, policymakers and organisations about citizen science. Thanks to citizen science, citizens can contribute to scientific research and projects, regardless of their background knowledge and/or they can initiate projects themselves. Scivil aims to strengthen the citizen science community and offers support for citizen science projects.

5.3.2. Citizen science-related policy documents

A. Introduction

The platforms for CS projects in Belgium make researchers' initiatives visible and tangible and also demonstrate the high level of interest among researchers in starting and promoting Citizen Science projects. This makes it even more important for university and policy-makers to engage with the concept and explore the opportunities offered by CS. In terms of government, significant opportunities exist for harnessing innovation, experimentation and involvement between citizens and scientists, as well as new knowledge processes and forms of knowledge production.

B. CS Policy-related documents

The desk research in Belgium found several documents in which CS was considered in the context of a strategy or plan (Table 6).

Table 16: *Policy related documents in Belgium*

Name of the document	Document type	Source of information
Citizen science roadmap for local government	roadmap	Scivil - Flemish knowledge centre for Citizen Science
Belgium Recovery and resilience plan	plan	Office of the Secretary of State for Recovery and Strategic Investments
BiodivERsA Citizen Science Toolkit	tool	Belgian Biodiversity Platform
Communication in citizen science	manual	Scivil - Flemish knowledge centre for Citizen Science

One of the most important documents is the Citizen science roadmap for local government that outlines what citizen science can mean for local government, explains how to get started, and identifies success factors.

The Belgian Recovery and resilience plan set ambitious targets - financing 356 green buses for public transport, promoting the deployment of over 78,000 electric charging stations, improving railway infrastructure and intermodal platforms in ports across the country, and creating or renewing 1500 km of cycling pathways. And it is also financing a more inclusive and future-proof education system across communities with improved digital and STEM (Science, Technology, Engineering, and Math) skills of students and access to digital tools and technology.

The BiodivERsA Citizen Science Toolkit informs scientists who are working in the fields of biodiversity and, more generally, in environmental sciences, about the potential benefits of Citizen Science and provides a summary of the rationale to develop CS, current best practices, and useful resources in the field. It is aimed at researchers and scientists involved in research projects using CS for data collection or public/stakeholder engagement (or where they could use existing data). It is expected that this could help scientists to better consider different dimensions and potential uses of CS as part of their research projects.

The manual Communication in citizen science includes tactics, tools, and handy tips to ensure initial participation and continued engagement of citizen scientists and guides you through building a communication plan for your citizen science project.

After analysis of the result from the implementation of the CS project in Belgium were found documents that can be used as a guideline for the wide promotion of CS, citizens engagement and implementation of the CS project.

Table 17: CS documents

Project name	Description of the document	Document
Animals Under Wheels	<p>For many animals, traffic is the main unnatural cause of death. With the "Animals under the wheels" project, the Flemish government and Natuurpunt want to further map out the bottlenecks. They therefore call for reporting sightings of road victims via www.dierenonderdewielen.be or www.waarnemingen.be. Even better is to register your route while driving.</p>	Dutch manual
BikeSTEM for Schools	<p>The Institute for Sustainable Mobility (IDM) of Ghent University is surfing along on the success of the FietsTelweek, to map out (i) the bicycle safety and friendliness of school environments through "Citizen Science"; and (ii) to teach GIS skills to third grade students of secondary education.</p>	Discovering more about BikeSTEM
CitizenHeritage	<p>Exploring the role of Higher Education Institutions (HEI) as incubators of the next generation open science citizens, in terms of staff and student skills, curricula and interdisciplinarity, and as institutions situated in a broader social context where citizens advocate a more important role in decision taking in modern societies with active citizenship, civic engagement, bottom-up public intervention, unlocking the still unused potential in connecting the user engagement generated through civic participation with the open science cycle.</p>	Review of practices of Higher Education engagement in citizen enhanced open science in the area of cultural heritage
	<p>Improving methodologies of co-creation and user engagement with cultural heritage with better alignment within the educational context, also making students in Cultural Studies and Humanities closer to Cultural Heritage Institutions, thus lowering the threshold between the university and the later employment field.</p>	Methodology, user requirements and guidelines for Cultural Heritage Institutions and Universities
CurieuzenAir	<p>The report provides a description of the scientific research during the citizen project CurieuzenAir, which has mapped the air quality (atmospheric NO₂ concentrations) across the Brussels Capital Region in October 2021. The report describes (1) the data collection with the help of citizens, (2) the quality control and processing of data, and (3) an overview of the resulting dataset</p>	The CurieuzenAir results - scientific report

Project name	Description of the document	Document
CurieuzeNeuzen 2016	The results of the CuriousNoses, a citizen science project in which 2000 citizens of Antwerp measure the air quality outside their window.	the results
CurieuzeNeuzen 2018	The results of the CuriousNoses, a CS project in which 20.000citizen of Flanders measure the AQ. Paper about how CS is transforming research and things they learnt about Curious Nose.	International public papers & the results
hackAIR	This report, reports the hackAIR pilot deployment activities in Norway, Germany, Greece, Belgium and England.	HackAIR report
iSCAPE	Reports about passive control systems, behavioural interventions, urban planning, climate change and air pollution, environmental and socio-economic impacts, living lab activities & sensors (e.g. citizen kit and living lab station)	results of the project
My Gardenlab	The results about the role of green spaces on mental well-being through a survey show, among other things, that the ecological quality of gardens (depending on, among other things, the biodiversity score and variety of nature in the garden) is linked to lower feelings of depression due to an increase in activities in the garden. Green space around the home is linked to spending more time in public areas such as parks or nature reserves, which in turn is associated with lower feelings of stress and depression. Feeling connected to nature also (indirectly) had a positive impact on our well-being.	Paper about the impact of gardening on your health
Scivil	gives basic information in different steps on how to run a citizen science project and we'll refer you to the most relevant sources to read more about the subject	Getting Started' guide
	manual guides through the building of a communication plan for your citizen science project	Communication in citizen science - manual

Project name	Description of the document	Document
	a roadmap and pointers for local governments to get involved with citizen science	Citizen science for local government - roadmap
	contains recommendations and tips for handling data in citizen science projects	Data charter and guide for citizen science
TriAS	Publications, published datasets & risk maps	Open data-driven framework
WeCount	Reports about the CS project (Leuven, Madrid, Cardiff, Dublin & Ljubljana), exploitation strategy.	Deliver. of the project

The documents contain a methodology on how to run SC projects step by step, how to communicate and a roadmap for local authorities on how to involve the citizens in SC initiatives.

C. Study of CS in Local and Regional Sustainable Urban Mobility Plans (SUMP) and Environment policy plans

The analysis of strategic documents related to air quality and sustainable transport in Flanders and how they fit into the CS is shown in the table below. The columns correspond to the questions within the methodological framework.

Table 18: CS in SUMP and Environment policy plans

Name of the document (including hyperlink)	1 CS covered	2. Citizen involvement	3. Co-creation / co-design	4. Citizen data collection	5. Citizen evaluation
Air policy plan		x			
Climate Plan 2030 - City of Genk		x	x		
Air & Noise policy plan - City of Ghent		x		x	

The Air policy plan formulates Flemish objectives as measures to improve air quality in Flanders, frames them within the European policy context, and how we will achieve these objectives through citizen involvement.

The Climate Plan 2030 - the City of Genk- the plan includes the intention to involve the local citizens through a citizen participation platform and allows them to participate in the co-creation process.

The Air & Noise policy plan - City of Ghent contains measures for citizen involvement and data collection from citizens.

Brussels launches Europe’s largest CS project on air quality. Through simultaneous measurements at 3.000 different locations, CurieuzenAir aims to map the air quality across the Brussels-Capital Region with unprecedented spatial detail. To this end, families, companies, associations, and schools will be allowed to measure the air quality in their streets. On the website, <https://www.hasselair.ucll.be/> can be found Real-time air quality measurements for and by citizens in Hasselt. Through the site <https://www.genk.be/klimaatplan>, citizens are encouraged to help the city evaluate some traffic measures during the development and try out traffic plans on the neighbourhood level by counting traffic with Telraam sensors.

All these initiatives show that citizens are deeply involved in the policy process.

5.4. Policy landscape review – Plovdiv/ Sofia, Bulgaria

5.4.1. Citizen science projects

The analysis of the SC projects and initiatives in Bulgaria (D2.2) mapped 20 samples. Most of them are EU funded and dedicated to biodiversity and air quality. In Bulgaria is observed a lack of CS projects and a lack of citizens participation in such activities. The meaning of the term "citizen science" is unclear and often there is no distinction made between citizen science and rising awareness.

The CS project with wider civil participation is in the sphere of air quality and biodiversity. Regarding the air quality, citizens are involved only in data collection and visualisation on a project dashboard. There is no possibility for co- creation, data analysis and communication with the policymakers.

Regarding biodiversity the situation is common. The citizens only collected data and visualised it on a map.

Table 19: CS projects in Bulgaria

Field	Projects	Total	Participation and engagement
Air quality monitoring	AirBG, HEAL Sofia, Dustcounters, IQAir Sofia, METER.AC	5	Citizens are involved in data collection in almost all of the listed projects.
			Regarding data analysis - most of the projects offer some kind of platform for data access or visualisation and not data analysis.

Field	Projects	Total	Participation and engagement
			Regarding participation in the decision-making process - there is no possibility for the citizens to participate in the policymaking process
Biodiversity monitoring	Alien CSI, The Quest for the Storks, ANEMONE, RECONNECT, Gecko monitoring, PECBMS, Let's count the sparrows	7	<p>All projects involve citizens as part of the data collection process, but most of them don't offer any comprehensive data analysis workshop/meeting with citizens. An exception is the project Anemone, where workshops were organised for networking of policy makers, NGO, research and education, media, students, teachers, citizens.</p> <p>In terms of decision-making, the collected data from some of the projects are available on a project website or platform for all stakeholders. The projects are led by academic organisations and data were mostly used for scientific purposes, not for the policymaking</p>
Monitoring of water quality, vegetation, environment, waste and odour pollution	DNOSES, EdnoDarvo, GLOBE BG, Shared, Compost, Watermap of Bulgaria	5	<p>Citizens are involved in the data collection process, for mapping and visualisation on different platforms.</p> <p>In terms of contributing to decision-making processes - only the DNOSES project offered a possibility for common work between local authorities and citizens for improvements of the municipal system for separate collection of waste.</p>
Social sciences, humanities and arts	CitizenHeritage, REFRESH, Citizens' App	3	<p>Citizens are involved in the data collection process, for mapping and visualisation on different platforms</p> <p>Regarding participation in the decision-making process - there is no possibility for the citizens to participate in the policymaking process</p>

The CS initiatives in Bulgaria are complex - global initiatives, European initiatives, EU-funded projects (outside-in initiatives), and activities started by local and regional stakeholders and active citizens.

The financing of the projects is mostly EU funding. There isn't a national financing scheme for CS projects and initiatives.

In the field of Air quality monitoring citizens are involved in data collection and visualisation on a platform and no data analysis or policy making process. The citizens cannot participate in the policymaking process. In the project AirBG citizens buy themselves low cost air quality sensors and connect to the specific network to share measured data. The citizens participating in the METER.AC initiative received devices for measurements of air quality and meteorological conditions and connected to the specific network to share measured data. The platforms with measured data are available for free online, but there is a lack of information on whether this data is used by policymakers.

All of the projects in the field of biodiversity involve citizens as part of the data collection process, but most of them don't offer any comprehensive data analysis workshop/meeting with citizens. An exception is project Anemone, which organised workshops for networking of policymakers, NGOs, research and education, media, students, teachers, and citizens. The collected data from some of the projects are available on a project website or platform for all stakeholders. The projects are led by academic organisations and data were mostly used for scientific purposes, not for policy making.

The projects in the field of Monitoring water quality, vegetation, environment, waste and odour pollution engaged citizens in the data collection process, for mapping and visualisation on different platforms. In terms of contributing to decision-making processes - only the DNOSES project offered a possibility for common work between local authorities and citizens for improvements of the municipal system for separate collection of waste.

The projects in the field of Social sciences, humanities and arts engaged citizens in the data collection process, for mapping and visualisation on different platforms. The citizens cannot participate in the policymaking process.

The leading partners in the projects were universities and non-governmental organisations and one initiative was led by the Municipality of Sofia.

The citizens are involved mostly in data collection, but not in data analysis and decision-making process.

5.4.2. Citizen science-related policy documents

A. Introduction

The CS initiatives are not widespread in Bulgaria. There is information about different implemented and ongoing projects, but they are not organised in a systematic approach, and the citizens are involved in the data collection and visualisation process. These are single initiatives, with no connection between them.

In June 2020, the Bulgarian Portal for Open Science (BPOS) started operating and a national repository for open access to scientific information which connects researchers, research institutions, and policymakers at a national level was launched. The publication's aim was to show the scientific achievements and results to a broad audience.

B. CS Policy-related documents

Following desk research in Bulgaria, no documents were found in which CS was considered in the context of a strategy or plan. During the study, some strategic documents that contain measures related to citizens' involvement were found (Table 8).

Table 20: Policy related documents in Bulgaria

Name of the document	Document type	Source of information
National Plan for Development of the Open Science Initiative in the Republic of Bulgaria	plan	Ministry of Education and Science
National Recovery and Resilience Plan	plan	Council of ministers Bulgaria
Plan for integrated development of municipality Plovdiv and municipality Sofia	plan	Municipality Plovdiv
INNOVATION STRATEGY FOR INTELLIGENT SPECIALISATION OF SOFIA and of PLOVDIV	strategy	Sofia Municipality
Digital Transformation Strategy for Sofia	strategy	Sofia Municipality

The Bulgarian Portal for Open Science provides quick and easy access to scientific information and publicly funded research outputs, including resources from institutional open access repositories in Bulgaria. The national repository is a trusted space that allows the dissemination and storage only of scientific publications and research outputs. Its primary purpose is to assist the work of researchers and institutions that do not have an institutional repository available.

The National Recovery and Resilience Plan aims to modernise teaching tools and enhance learning in the fields of science, technology, engineering and mathematics (STEM) subjects in Bulgarian schools through the construction and/or refurbishment of a national and three regional STEM centres. The project also foresees the establishment of more than 2 200 STEM laboratories in schools, including high-tech classrooms, which will promote the digital literacy and teaching methods of STEM subjects.

The pilot area in Bulgaria consists of two playgrounds - the municipalities of Plovdiv and Sofia.

Both municipalities have standard strategic documents:

- Plan for integrated development - defines the medium-term goals and priorities for sustainable development for the period 2021-2027. The document links the advantages and potential for development at the local level with a clearly defined vision, goals, and priorities in the municipality and sustainable development of the territory. It includes measures for raising citizens' awareness of environmental issues and sustainable mobility.
- Innovation strategy for intelligent specialisation - outlines the sectoral specialisation of the capital cities' economy following the innovative potential and priority guidelines in developing scientific research and innovations. Determines the economic priorities within the framework of research and innovation activities to create a competitive advantage by strengthening the link between their scientific accomplishments and the needs of industry and market niches. The aim is to respond to the new opportunities and changes in the market by concentrating investments in areas that provide increased added value to the economy and its competitiveness on the international markets.

The Digital Transformation Strategy for Sofia defines the digital transformation policies of Sofia Municipality in the next 10 years through the introduction and use of high technology in all spheres of public and economic life.

After analysis of the result from the implementation of the CS project in Bulgaria were found documents that can be used as a guideline for the wide promotion of CS and citizens engagement.

Table 21: CS documents

Project name	Description of the document	Document
CitizenHeritage	Exploring the role of Higher Education Institutions (HEI) as incubators of the next generation open science citizens, in terms of staff and student skills, curricula and interdisciplinarity, and as institutions situated in a broader social context where citizens advocate a more important role in decision taking in modern societies with active citizenship, civic engagement, bottom-up public intervention, unlocking the still unused potential in connecting the user engagement generated through civic participation with the open science cycle.	Review of practices of Higher Education engagement in citizen enhanced open science in the area of cultural heritage
	Improving methodologies of co-creation and user engagement with cultural heritage with better alignment within the educational context, also making students in Cultural Studies and Humanities closer to Cultural Heritage Institutions, thus lowering the threshold between the university and the later employment field.	Methodology, user requirements and guidelines for Cultural Heritage Institutions and Universities
DNOSES	The Green Paper on Odour Pollution is a policy document that aims to place odour pollution in the policy agendas by providing recommendations to better tackle the issue and move towards an improved regulatory framework in Europe	Green Paper on Odour Pollution
	These guidelines aim to support citizen science projects operating in odour-conflicted communities. They are DIY guidelines – helping you to ‘do it yourself’ – and offer tested tools and practical tips for running projects and adapting them to different contexts	DIY guidelines for citizen science projects in odour-conflicted communities
Gecko monitoring	results from monitoring the presence of the species in the region thanks to the efforts of all involved specialists and volunteers	scientific publication CITIZEN SCIENCE ASSISTED MONITORING PROVIDES NEW DATA CONCERNING THE DISTRIBUTION OF THE BULGARIAN BENT TOED GECKO, MEDIODACTYLUS DANILEWSKII STRAUCH GEKKONIDAE, SQUAMATA, IN NORTH EAST BULGARIA
HEAL Sofia	evaluation of the PM in and around the city's schools	Report SOFIA-Elevated particulate matter pollution in and around the city's schools

The document contains explanations about the importance of the role of the citizens participation in such activities, toll for user engagement and how to tackle different issues and how to conduct monitoring.

C. Study of CS in Local and Regional Sustainable Urban Mobility Plans (SUMP) and Environment policy plans

The analysis of strategic documents related to air quality and sustainable transport in Plovdiv and Sofia and how they fit into the CS is shown in the table below:

Table 22: CS in SUMP and Environment policy plans

Name of the document (including hyperlink)	1 CS covered	2. Citizen involvement	3. Co-creation / co-design	4. Citizen data collection	5. Citizen evaluation
Green City Action Plan for Sofia		x		x	
Sustainable Urban Mobility Plan for Sofia 2035		x		x	
Municipality of Plovdiv - program for improvement of air quality and Action plan 2018-2023		x			
Municipality of Sofia - program for improvement of air quality and Action plan 2021-2026		x			

The Green City Action Plan for Sofia aims to improve the environment and air quality. The plan includes measures for citizens' involvement and data collection.

The Sustainable Urban Mobility Plan for Sofia 2035 aims to achieve a lasting change in the behaviour of passengers and the transition to sustainable forms of transport. The plan focuses on setting up the main actions to be considered regarding sustainable mobility in the city of Sofia. The plan includes measures for citizens' involvement and data collection.

Both municipalities - Plovdiv and Sofia- have plans to improve air quality. The plans include measures for raising the public awareness of the AQ issues, sustainable mobility (encouraging cycling and walking), and modernisation of systems for domestic heating.

In Bulgaria, the common understanding is that science comes from academic institutions (notably the Bulgarian Academy of sciences and universities). In fact, the universities are not so involved in research projects that contribute to real-life problems but only to theoretical and conceptual issues; there is no practical application of their research, only theoretical.

The term "citizen science" is vaguely defined in Bulgaria and mainly implemented by the NGO sector. It is necessary to introduce the term and definition as soon as possible for policymakers to adopt it.

The D2.2 Citizen Science Landscape Review identified CS projects in Bulgaria. The citizens are included mainly in data collection, not data processing and/or analysis. Often local authorities limit citizens' participation in the policymaking processes.

There is no recognition of the scientific value of non-academic research organisations by academic society and government institutions.

On the other hand, citizens do not trust official data. They suspect that data is manipulated. For this reason, many citizens joined the Luftdaten.info project to measure air quality with sensors, and the levels of pollutants are visualised on a map and are accessible through the site <https://airbg.info/>.

The implementation of COMPAIR in Sofia and Plovdiv aims at building a better connection between the local authorities and citizens and increasing the level of trust between them working on the common goal to improve air quality. Through the pilot actions we would like to achieve setting up officially the term "citizen science" in the normative document of both cities.

6. Conclusion

The EEA estimates that, in 2019, approximately 307,000 premature deaths were attributable to particulate matter (PM_{2.5}) in the 27 EU Member States. Nitrogen dioxide (NO₂) was linked to 40,400 premature deaths, and ground-level ozone was linked to 16,800 premature deaths.

Air quality is fundamental to the health and well-being of citizens. The high-quality, regulatory-grade data from the official ambient air monitoring station in the EEA network capture the trends in regional air quality. However, air sensors can play a role in supplementing that network with local air quality measurements. Measuring where people live, work, and play helps citizens gain better understanding about the air they breathe. Communities are understandably concerned, and participatory science can be part of the solution. Advances in the development and availability of air sensors, guidance, and data analysis and visualisation tools make it easier for the public to get involved in participatory-based air quality monitoring projects.

Nowadays, scientists can not capture the large volumes of data they need for solving the environmental challenges we face. The high costs of the official monitoring stations, both in terms of purchasing and maintenance, and the recent advances in mobile sensors and software applications, have raised an increased interest in setting up citizen-based sensing networks that complement the current air quality networks.

European citizens are more educated and connected than ever before, enabling many more people to participate actively in a wide range of research and innovation (R&I) activities. The development of technologies, IoT, mobile applications, and social networks enable citizens increased observation of phenomena and participation.. The low-cost air sensors are used mostly for supplemental monitoring (supplementing official reference data) and contribute to community near-source monitoring, public education, and detecting contaminated places.

Some citizens, particularly the better educated and wealthier, generally have more remarkable participation ability than others. This unequal representation is an important inhibitor for the use of citizen science in policy. The vulnerable and minority groups in society tend to be under-represented, which may be due to poor language skills, low incomes, unemployment, limited education, age, etc. Targeted action is needed to involve groups with low socioeconomic status. The **COMPAIR** project aims to overcome these barriers. Each pilot area will define the vulnerable groups on their territory and will suggest actions to include these groups in the project. The organisation of dedicated info campaigns and gatherings will raise awareness of vulnerable groups and allow them to participate in more activities related to CS without experiencing barriers.

Many implemented CS projects originated from the biodiversity field and seemed to have the potential to provide a step-up to other CS initiatives. These good practices of interaction between citizens and scientists can also be used in other fields, including air quality and sustainable transport.

Nevertheless, despite the powerful potential of citizens to contribute to science, citizen science has yet to be fully embraced by the scientific community and policymakers. The main barrier

to the scientific and political use of citizen science is related to concerns about the quality, consistency and reliability of citizen science data. The scientists are sceptical about them. These may be related to uneven recording intensity over time, uneven spatial coverage, uneven sampling efforts and variations in the data collection type. Sounds that the scientific community concerns are unfounded and probably more to do with ego, and meritocracy than actual quality of the data. The power of CS is to detect problems quickly and to generate possible solutions through the involvement of more actors. Depending on the case, local authorities/ policymakers may request expert opinion or measurements with accredited equipment.

Quality control processes are crucial and need to be related to each phase of the Citizen Science project, e.g. before, during or after data collection. Training of volunteers is the essential first step to ensure good quality data. It is also vital that the experiences of grown-up citizen science initiatives create the necessary conditions for effective policy use. These conditions go beyond the quality of the data collection.

Interest in citizen science in Europe has been steadily increasing in recent years. The active participation of public representatives in the formation and implementation of policies and legislation is one of the essential criteria for the degree of democracy and effective exercise of public power. For this reason, the European institutions, and in particular the European Commission, are taking many actions to ensure and use the opportunities of civil society in the decision-making process. Full public participation in this process is ensured by providing access to information, ensuring better awareness of EU policies and legislative initiatives, etc. The European Commission continues to promote Citizen Science through research policy formulation and direct support because of its potential benefits for European researchers, competitiveness, and society. The support is expressed in targeted policies and programs presented in Part 3. Policy landscape review at the European level.

The first part of the policy landscape review for each pilot (Belgium, Bulgaria, Germany, and Greece) aims to identify if there are any CS Policy-related documents.

The research on CS policy-related documents in pilot countries shows that such records are unavailable in Bulgaria and Greece. But found other strategic documents containing measures related to citizens' involvement. The term "citizen science" is not clearly defined. The availability of a definition will allow the adoption of CS as a tool for evaluating the implementation of the proposed measures in strategic documents.

The desk research in Belgium found several documents in which CS was considered in the context of a strategy or plan. One of the most important documents is the Citizen science roadmap for local government, which outlines what citizen science can mean for local government, explains how to get started, and identifies success factors.

Germany also has a firm policy dedicated to recognizing and adopting CS. This finds expression in Green Paper Citizen Science Strategy 2020, followed by White Paper Citizen Science - Strategy 2030 for Germany.

The German and Belgium examples should be followed and replicated by Bulgaria and Greece. In the first place, within the CompAir project, Bulgaria and Greece, with the support

of other consortium partners, will define what a CS is. Then, the definition needs to be adopted by local policymakers so that the local strategic documents address and promote the CS adequately.

The National recovery and resilience plans of Belgium, Bulgaria, Germany, and Greece envisage the steady expansion of the STEM disciplines from theory to real-life application. In the school setting, students can gain more knowledge and experience through measuring different parameters with sensors, monitoring data on dashboards, and using the augmented reality app offered by the CompAir project. Thus, the school curriculum may benefit from the CompAir project outputs and can successfully embed the project into the overall STEM training of the students.

The second part of the policy landscape review for each pilot (Belgium, Bulgaria, Germany, and Greece) aims to identify if there are any CS Policy-related documents.

In all pilot areas, strategic documents related to air quality and sustainable transport were identified that cover measures for citizens' involvement.

All of Athen's strategic documents included measures for co-creation/ co-design. Athens Resilience Strategy for 2030 envisaged data collection by citizens.

Berlin's Energy and Climate Protection Programme and Berlin Noise Action Plan included measures for co-creation/ co-design.

Flanders region's Climate Plan 2030 - the City of Genk includes measures for co-creation/ co-design and Air & Noise policy plan - the City of Ghent envisages data collection by citizens.

For the pilot area in Bulgaria, the Green City Action Plan for Sofia and Sustainable Urban Mobility Plan for Sofia 2035 envisage data collection by citizens.

During the development of the AQ action plan, data from the low-cost sensors could be used to understand the local air quality better. The standard AQ measurement stations are fixed in concrete locations and could not give an overview of the current situation in the whole city area. The advantage of citizens' AQ real-time measurements is providing a holistic picture of air pollutants concentrations. The data from sensors in the COMPAIR project will be validated, and policymakers can use them to justify the proposed measures and policies.

For SUMP development, understanding traffic flow is key to comprehending current travel patterns and designing practical solutions. Many cities have a system for traffic counting, fixed on different locations and could not present the traffic situation over the city. The citizens can provide dynamic counting that can be a valuable contribution to the various analyses based on actual street use in a wide area. The data can identify important bike corridors, capture cycling trends, and justify possible investments in cycling infrastructure. The population's participation in collecting and analysing data will raise their awareness, capacity, and better acceptance of local policies for sustainable transport. Even more- they can suggest solutions, giving them the feeling that they are a part of the community's efforts and could do something for a better common future.

The AQ is directly linked to the traffic. Reduction of both AQ and GHG emissions from traffic led to the air quality improvement and contributed to climate change mitigation. Participation of the citizens directly in data collection and discussions of the results will lead to better understanding how the local climate and actions would impact global climate change.

The current document shows that these limitations can be overcome by making citizen science outputs actionable personally and turning them into valuable data sources for environmental policymaking in urban environments. The COMPAIR project addresses them by providing innovative, advanced tools and standards for improving both the quality of citizen science outputs and its use in both local and city decision-making mechanisms, but it also focuses on how to forge better collaborations between citizen scientists, policymakers, and the broader social fabric (comprising business and NGOs, among others).

Through the current policy review, the COMPAIR project has explored how citizen science can contribute to the many elements needed to realise efficient and effective environmental change and has shown their benefits to the policy making process and the real-life challenges of air pollution.

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